RESEARCH MATERIAL No.138

AAAS Symposium

National Innovation Strategies in the East Asian Region

(Feb 16, 2007 U.S. San Francisco)

Feb 2007

National Institute of Science and Technology Policy (NISTEP)

Ministry of Education, Culture, Sports, Science and Technology (MEXT)

AAAS Symposium
National Innovation Strategies in the East Asian Region

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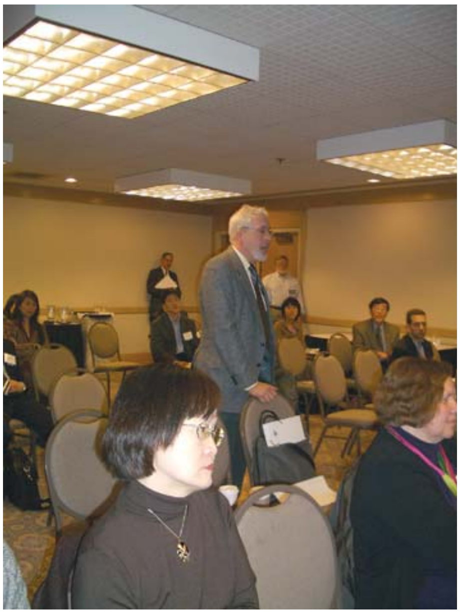
Ministry of Education, Culture, Sports, Science and Technology (MEXT)


H.TOMIZAWA



Preface

Staff of the National Institute of Science and Technology Policy (NISTEP), a unit of the Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT), organized a symposium titled "National Innovation Strategies in the East Asian Region," at the Annual Meeting of the American Association for the Advancement of Science (AAAS) in San Francisco on February 15-19, 2007.

The symposium, which was held on February 16, was one of the most recent collaborative initiatives among Japan, Korea and China. Representatives from leading research institutes in China and Korea in the area of science and technology policy studies joined two representatives from NISTEP as speakers at the symposium. Participating institutes from China were the National Research Center for Science and Technology for Development (NRCSTD) of the Ministry of Science and Technology, People's Republic of China and the Institute of Policy and Management of the Chinese Academy of Sciences (IPM/CAS). Participating from Korea were the Korea Institute of Science and Technology Evaluation and Planning (KISTEP) and the Science and Technology Policy Institute, Korea (STEPI). Ms. Yaeko Mitsumori of NISTEP served as the organizer of this symposium. Dr. Fumihiko Kakizaki of MEXT and Prof. Christopher T. Hill of George Mason University served as co-organizers. Prof. Hill also moderated the symposium.

The purposes of the symposium were (a) to share information about the current status of science and technology policy studies in each country; (b) to identify the achievements, challenges and problems of each country; and (c) to discuss future directions. The symposium was also intended as a forum for sharing the three countries' experiences with attendees from the United States and other countries

This report summarizes the presentations and discussions held at the symposium.

The organizers wish to thank the Japan Society for the Promotion of Science (JSPS) San Francisco office for important contributions to the symposium. The organizers also wish to thank Mr. Hiroshi Nagano, Executive Director at Japan Science and Technology Agency (JST) and a former Director General of NISTEP, for his leadership and encouragement which led the symposium to a big success.

Program

"National Innovation Strategies in the East Asian Region"

Date: Feb 16 (Friday) 13:45 – 16:45
Site: Renaissance Parc 55 Hotel, San Francisco
Room: Barcelona II

Moderator：
Dr. Christopher Hill
Professor of George Mason University, United States:

Session 1

"National Innovation Strategies in the East Asia: Framework and Policy Implication"

JAPAN – NISTEP
Speaker: **Mr. Terutaka Kuwahara**
Deputy Director General, NISTEP
Title of the speech:
"Japanese Innovation Strategies based on the 3rd S&T Basic Plan"

CHINA –NRCSTD
Speaker: **Dr. Yang Qiquan**
Deputy Director-General, National Research Center for Science and Technology for Development,
Ministry of Science and Technology, P.R.China
Title of the speech:
"China's S&T Innovation Strategies"

KOREA--STEPI
Speaker: **Dr. Sungchul Chung**
President, STEPI
Title of the speech:
"Evolution of the Korean Innovation System"

Session 2

"National Innovation Strategies in the East Asia: Policy Analyses and Evaluation"

JAPAN – NISTEP

Speaker: **Mr. Hiroyuki Tomizawa**

Director of Research Unit for Science and Technology Analysis and Indicators, NISTEP

Title of the speech:

"Japan's Latest S&T System Reforms and Innovations: An Evaluative Analysis"

CHINA-IPM/CAS

Speaker: **Dr. Mu Rongping**

Director-General and Professor, Institute of Policy and Management, Chinese Academy of Sciences

Title of the speech:

The Changing National Innovation Strategy in China: Policy Analyses and Evaluation

KOREA - KISTEP

Speaker: **Dr. Jiyoung Park**

Director, R&D Feasibility Analysis Team, KISTEP

Title of the speech:

"Challenges and Responses for Korea's National Innovation System (NIS)"

Symposium Overview

Today the East Asian region plays a key role in S&T activities in the world. It would not be exaggerated to say that the East Asian region holds huge S&T intensity which is comparable to the European region. One of the most remarkable features of S&T in East Asian region, which consists of China, Japan and Korea (C-J-K in alphabetically), is each country has achieved its growth under national innovation strategies. Therefore, studies on national S&T policies in this region could provide very useful suggestions to non-Asian policy makers, scholars and practitioners.

This symposium is the brainchild of an on-going trilateral dialogue among research institutes in C-J-K on S&T policy planning and strategy research. Through the discussion at the first trilateral meeting held in January 2006 in Tokyo, Japan, these three countries successfully deepened their understanding of both similarities and differences in their systems and practices. For the next step they feel committed to show what has been happening in East Asia to their U.S. counterparts and the larger S&T community.

The symposium consists of two parts. Part 1: "National Innovation Strategies in East Asia: Framework and Policy Implications." In this part, each country introduced the present situation of innovation policies and processes under the national strategies. Part 2: "National Innovation Strategies in East Asia: Policy Analyses and Evaluation." In this part, each country representative discussed analyses and evaluations which were taken into account throughout the processes of national innovation strategies.

Organizer:

Yaeko Mitsumori
Coordinator of International Research Cooperation
NISTEP, MEXT

Co-Organizers:

Christopher T. Hill, Ph.D.
Professor of Public Policy and Technology, School of Public Policy
George Mason University

Fumihiko Kakizaki (Dr.)
Senior Specialist
Research and Coordination Division
Science and Technology Policy Bureau, MEXT

National Innovation Strategies in the East Asian Region

Opening remarks

Dr. Christopher Hill, George Mason University, United States:

Good afternoon. Thank you for coming. My name is Chris Hill. I am the moderator and a co-organizer of this afternoon's session. I am a professor at George Mason University and also a consultant with the firm of Technology Policy International. Our subject this afternoon is national innovation strategies in the East Asian region.

I would like to introduce a person who has been very important to the establishment of this symposium: Mr. Hiroshi Nagano of the Japan Science and Technology Agency. Mr. Nagano is a former Director General of NISTEP (The National Institute of Science and Technology Policy of Japan). I also introduce Mr. Nagano because of his role in bringing together Korean, Chinese, and Japanese science and technology policy planning officials in a very interesting activity involving the three countries.

I am pleased to have played a very modest role in bringing this group together this afternoon and do appreciate my colleagues' efforts to make it happen. I would especially like to recognize and thank Ms. Yaeko Mitsumori, my co-organizer, who is Coordinator of International Research Cooperation at NISTEP. We would both like to thank our co-organizer, Dr. Fumihiko Kakizaki, formerly with NISTEP and now with the Ministry of Education, Culture, Sports, Science and Technology of Japan.

The three countries are in different stages of economic and technological development and change. From an American perspective, however, all three countries are very challenging. We welcome the challenge, but we also value the opportunity to cooperate.

There is an interesting emerging collaboration involving the People's Republic of China, the Republic of Korea, and Japan in the field of science and technology policy and planning, which we will hear about today. In January 2007, the three nations met in a ministerial-level meeting about collaboration in science and technology. They issued a joint statement of intent to cooperate in a number of very important fields in science and technology, as well as to continue their trilateral conversation.

We have six speakers, two each from China, Korea, and Japan. We will break the session into two sections of approximately 1.5 hours each and will take a very short break in the middle to change speakers. The first section, featuring the three speakers on my right, will deal with broad national strategies for innovation. The second session will deal with more specific issues in policy planning and evaluation and specific programmatic initiatives. We will have a Q&A portion at the end of each section. I will not use a lot of time introducing each of our speakers. I would rather hear them talk about the substance than hear me talk about them.

$\boxed{\text{Session 1}}$

"National Innovation Strategies in the East Asia: Framework and Policy Implication"

Mr. Kuwahara Presentation

Dr. Hill: The first speaker this afternoon is the Deputy Director General of the National Institute of Science and Technology Policy in Japan, Mr. Terutaka Kuwahara, who will speak to us about the planning and development of innovation policy in Japan. Mr. Kuwahara, please.

Mr. Terutaka Kuwahara, Deputy Director General, NISTEP: Thank you. Good afternoon. The Japanese science and technology policy has changed from a research oriented one to an outcome oriented one over the past decades. In my presentation, I would like to introduce to you changes in science and technology policy and administrative structures, and I also would like to introduce what is going on to enhance innovation policy recently.

[Slide 3] This graph shows Japanese GDP growth as well as national investment for research and development, including industry. The blue line is R&D. You can observe rapid growth in the 1970s and 1980s. However, the situation changed in the early 1990s. The R&D investment level became saturated for several years. But recently it has been increasing again. However, the GDP growth rate is very low, and a problem arises from this. We have to introduce a new science and technology policy to vitalize our economy. We have received criticism from the government people who are responsible for industrial and economic policy that the economic impacts of public R&D are not enough. [Slide 4] Traditional Japanese science and technology policy was formed by the so-called “bottom-up system.” We had three sectors, or three levels, of the decision making process. On the top, there was the former Science and Technology Council chaired by the Prime Minister, and then in the middle there were many ministries in charge of research and development. Many research organizations, including national universities, were on the bottom of the chart. But the key players were the R&D organizations, and every important decision was made on the bottom level, and this system worked well in the 1970s and 1980s. In those days the Japanese economy was growing very rapidly, so the government had enough investment capability for new fields or new emerging technologies.

[Slide 5] But the situation changed, and the government introduced the Science and Technology Basic Plan, a five-year national program. The first program started in 1996, and the second one started in 2001, and we are now in the Third Basic Plan period. There are several important ideas. The first point is to expand government expenditures for science and technology. The government declared in the First Basic Plan to double the government investment to Y17 trillion in five years, to Y24 trillion in the second plan, and to Y25 trillion in the third plan. The role of the government to promote diversified basic research was emphasized in all of the Basic Plans. For applied research, the government did not introduce explicit prioritization in the First Basic Plan, however, in the second plan, it introduced prioritization by field. Life science, IT, environment and nano-technology/materials were selected as high-priority fields. In our latest plan, more sophisticated prioritization has been introduced, and prioritization within the field is now being carried out.

[Slide 6] For science and technology systems, an important point is how to introduce a competitive environment. The national universities and institutes have been reformed to become more independent. At the beginning of 2001, the government administration system was reformed, and the Japanese S&T policy system changed from a decentralized one to a more centralized one. These are some aspects of the government’s reforms. Before 2000 we had 23 ministries and agencies, but now we have only 13, and the important point was the establishment of the Council for Science and Technology Policy in the Cabinet Office.

[Slide 7] Both the former council and the new council are chaired by the Prime Minister, and a change is that the former Council meeting was held only once a year, but today the Prime Minister holds a Council meeting every month. Every important decision is discussed and decided before the Prime Minister today. Now the Council for Science and Technology Policy is a very powerful one, and important decisions are decided by the Council, so the new stream from top to bottom is working well now.

[Slide 8] This is the allocation of the budget within the ministries. Before 2000, we had three large ministries: the Ministry of Education for basic science, the Science and Technology Agency (STA) for big science, and the Ministry of International Trade and Industry (MITI) for industrial research. The Japanese Government system was divided into administration for basic research, intermediate research, and applied research. The Education Ministry and the STA are merging into a new big ministry, MEXT. MEXT is responsible for basic research and applied research, and other mission-oriented ministries conduct applied research and technology development, and there are interactions among ministries under the CSTP. It is an important point.

[Slide 9] The key players are the national universities. All of the national universities were reformed into independent corporate entities in 2004. Before that, Japanese national universities were strongly controlled by the Ministry. As for the national university budget, the share of competitive research funds has been increasing, and the government is enhancing university-industrial collaboration.

[Slide 10] This chart shows the budget of competitive funds. You can observe that in the past 15 years, the competitive fund budget grew five times, and [Slide 11] this shows the amount of joint research between national universities and industry. The blue line is the amount of university-industry joint research. It dramatically increased at the end of the 1990s. [Slide 12] In the early 1980s, a very limited number of national universities engaged in joint research with industry, but recently almost all national universities carry out joint research. [Slide 13] From the viewpoint of industry, the number of joint research is increasing very rapidly, but the number of joint projects per company is not increasing as much. This shows that the number of companies engaged in this field is increasing. Not only big firms, but small and medium firms, also have contracts with national universities.

[Slide 14] This is the structure of our new Science and Technology Basic Plan. The basic ideas are shown on the top. This time the government introduced policy goal setting, so there are six major policy goals, for example, contribution to healthcare, vitalization of the economy, etc. As for resource allocation, there are two parts. Diversification is important for basic research, and strong prioritization is now introduced to applied-research-corresponding policy issues. There are several factors within system reform, and the important point is the second one: the creation of scientific development and persistent innovation. In the text of the latest Basic Plan, we can find the word “innovation” 40 times.

[Slide 15] This is an outline of the new priority setting. There are several prioritized fields, and this time the government selected some important technologies or key issues in life sciences, ICT, environment and nano-technology/materials. [Slide 16] The red part is highly-prioritized technology or issues, and this graph outlines the structure of the Japanese government’s science and technology budget. The total is Y3.6 trillion. --about US$30 billion. The left part, Y1.42 trillion, is devoted to basic science for national universities, and diversification is very important here. The middle part, Y1.8 trillion, is for policy-oriented subject research. Here, strong prioritization is introduced, and budget share of highly prioritized areas or technologies is about 16 percent of Y1.8 trillion.

[Slide 17] Next slide is science and technology system reform. The important agenda is to create a more competitive environment, and another important point is how to strengthen the competitiveness of universities. [Slide 18] This chart shows new policies decided by the Council for Science and Technology Policy for creating innovation last June. There are three phases, from basic level to product level. For basic research, the important role of the government is to enrich the source of innovation. For the applied research level, the important point is to strengthen the outcome-producing mechanism. For the development and market level, the government will introduce measures to enhance innovation. [Slide 19] As for the first agenda about the source of innovation, there are two points. The first point is to realize diversity and continuity of basic research, and the second point is that the government is now trying to build up world-class research centers within Japan with the participation of excellent researchers from all over the world, and MEXT is now preparing a new program to support a world-class research center in the fields of multi-disciplinary area in life science, chemistry, material science, and mathematics. This program will start in 2007.

[Slide 20] For mechanisms to produce new products and services from the seeds of innovation, collaboration is of course important among industry, academia and government, and also regional innovation plays an important role. [Slide 21] For example, how to organize good public procurement to enhance innovation and standardization is up to inter-ministry collaboration. This was one of the weak points of Japanese science and technological policy in the past, and now the government is taking measures for a policy-mix to enhance the linkage between S&T policy and other policies.

[Slide 22] The last point of my presentation is the Japanese government’s new initiative for future innovation. Prime Minister Abe gave a general policy speech to the Diet last September and introduced the Innovation 25 Initiative. This is a long-term strategy to create an innovative society by 2025, implementing not only technological approaches but societal system reforms.

[Slide 23] This is the schedule of our new Innovation 25 Initiative. The government already has established the Innovation 25 Strategy Council within the Cabinet Office, and members are now discussing what kind of society should be developed by 2025 and how to make Japanese society more innovative. The council is going to decide these points for the first step by the end of February 2007. The Science Council of Japan contributed to the Innovation 25 Initiative by providing its members' diversified concepts for the future. NISTEP, which I work for, provides social scenario analysis to support the decision makers. In the coming three month, detailed roadmaps will be discussed and decided by the council with a support of CSTP, and after that, with next year's budget, the government will implement detailed projects.

[Slide 24] In conclusion, promotion of innovation is an important political agenda. Prime Minister Abe gave a general policy speech last month to the Diet, and in his speech, Innovation 25 Initiative was the first issue. Another point is that the academic community plays an important role in this innovation initiative. Generally speaking, in the past Japanese academia stuck to basic science and would not address applied and societal discussions such as innovation policy, but the situation has changed.

Five years of the Third Basic Plan is a very important transition phase for the Japanese national R&D system to become a more innovation- or outcome-oriented one. Within the government, science and technology is treated as just one of the important components of the policy, but the decision makers or policy makers recognize the necessity of creating innovation. They are defining a more important role for science and technology policy, so from now on, policy mix for innovation will be the next major agenda for Japanese society and the economy. Thank you for your attention.

Dr. Hill: Thank you so much for a very interesting review and prediction of where things are going in Japan. I must say, from the US point of view, we cannot sleep.

National Innovation Strategies in the East Asia: SECTION 1: Framework and Policy Implication

Japanese Innovation Strategies based on the 3rd S&T Basic Plan

2/16/2007

Terutaka KUWAHARA

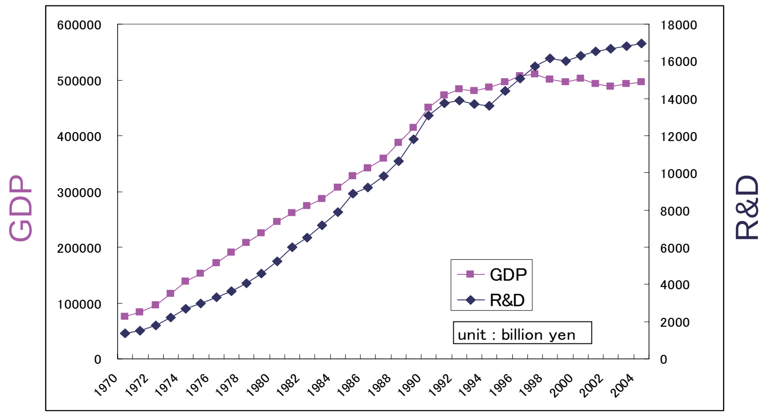
Deputy Director General
National Institute of Science and Technology Policy (NISTEP)
Ministry of Education, Culture, Sports, Science and Technology
Japan

Contents

1. Development and implementation of the Japanese S&T policy after 1990's

2. Analysis of the linkage between S&T policy and innovation policy in Japan.

GDP and R&D investment of Japan



Structure of national decision making in 80's and 90's

S&T Council — Coordination

Bottom up

Ministries — Planning, Implementation

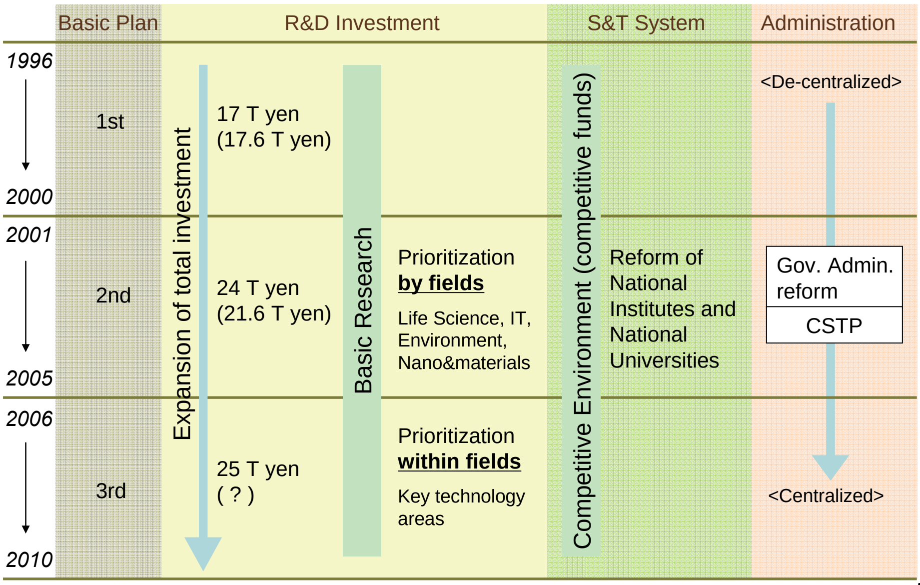
Bottom up

R&D Organizations

Bottom up decision making was dominant

Needs to build "consensus" for the future among sectors

Development of S&T Basic Plan



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Central Government Reform

- January 2001　Central Government Reform
  - Ministries/agencies with cabinet ministers 23 → 13
- Council for S&T
  → Council for S&T Policy
  - Advising comprehensive strategies for not only natural science but for social science
  - Responsible for Science and Technology Basic Plan
  - Secretariat : Cabinet office
- Ministry of Education / Science and Technology Agency
  → Ministry of Education and ST

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Change of Administrative Structure

<Before 2000>

S&T Council

Bottom up

Ministries

Bottom up

R&D Organizations

<After 2001>

Council for STP — **Prioritization Policy**

Top down
Bottom up

Ministries — **Implementation**

Top down
Bottom up

R&D Organizations

more independent

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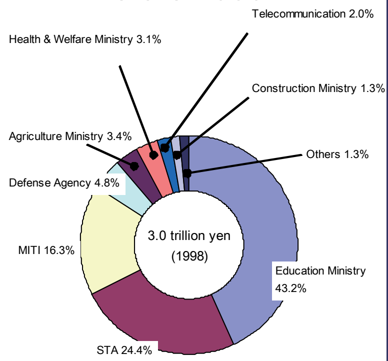
S&T Budget

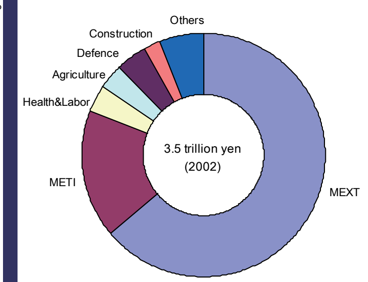
<Before 2000>



Basic science ⟷ Technological development

Education Ministry | STA | MITI, MOA etc

<After 2001>



Basic science ⟷ Technological development

MEXT | MITI, MHL etc

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Various Changes in National Universities

- Convert national institutes and national universities into independent corporate entities
- Improvement of graduate school system
- Increase of Post-Doctorates
- Increase of competitive research funds
- System reform for promoting activities of young researchers
- Increase of University-Industry collaboration

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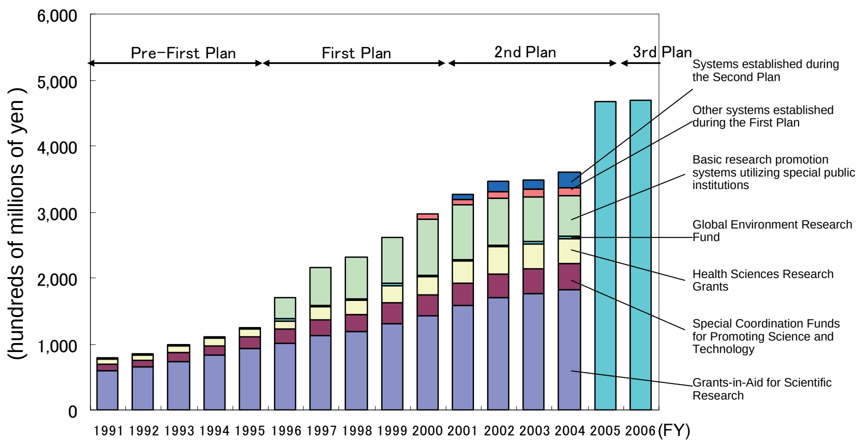
Trends in Budget for Competitive Research Funds



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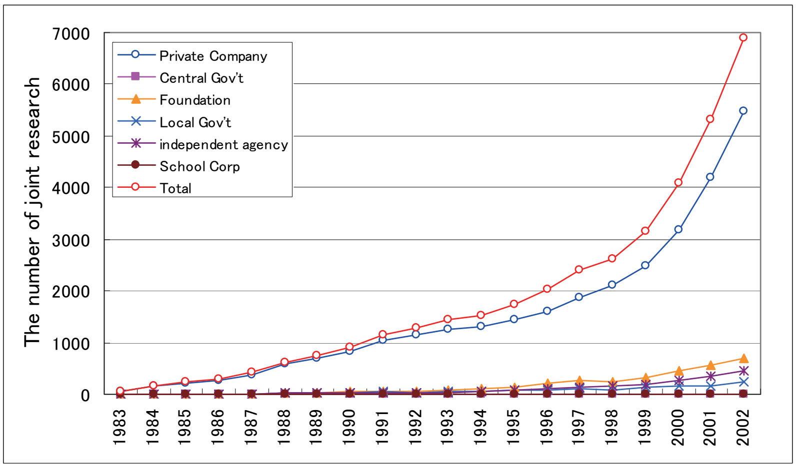
Trends of Joint Research in National Universities



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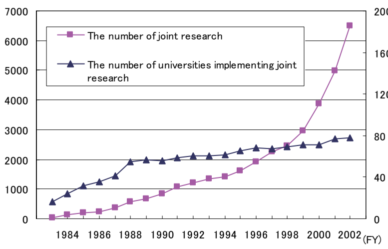
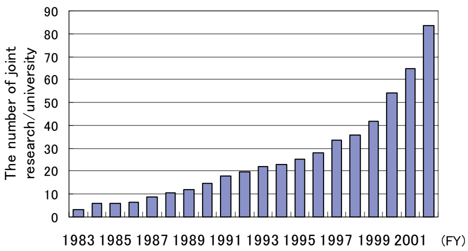
The factor of the increase in the number of joint research

-National Universities Side-

The number of joint research and the number of universities implementing joint research



The number of joint research per national university



Note: This charts cover 87 schools which are only national universities that became national university corporations, not including national research institutes, independent administrative institutions, national junior colleges, National Technical Colleges.

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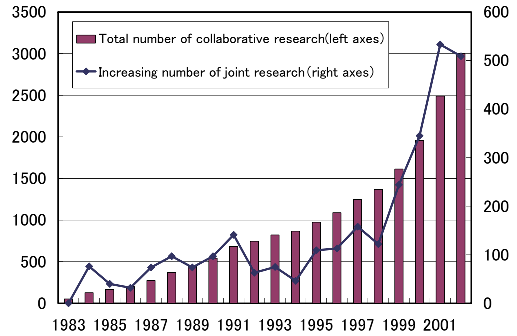
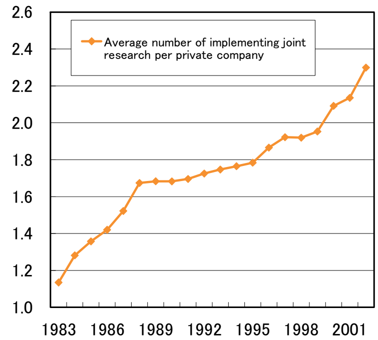
The factor of the increase in number of joint research

–Private Company Side-

Total number of joint research and increasing number of joint research in private companies



Average number of implementing joint research per private company



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Structure of the 3rd S&T Basic Plan

Basic Ideas

- Policy goal setting: 6 policy goals
- Governmental expenditures for S&T investment expected to reach 25 trillion yen over 5 years (on 1 % of GDP by 2010, with an expected annual growth rate of 3.1 %)

Resource Allocation

- Promotion of diversified basic research
- Prioritization of research for handling specific policy issues

S&T System Reforms

1. Fostering human resources as well as encouraging their S&T activities
2. Creating scientific development and persistent innovation
3. Strengthening the foundation for S&T promotion
4. Strategically promoting international activities

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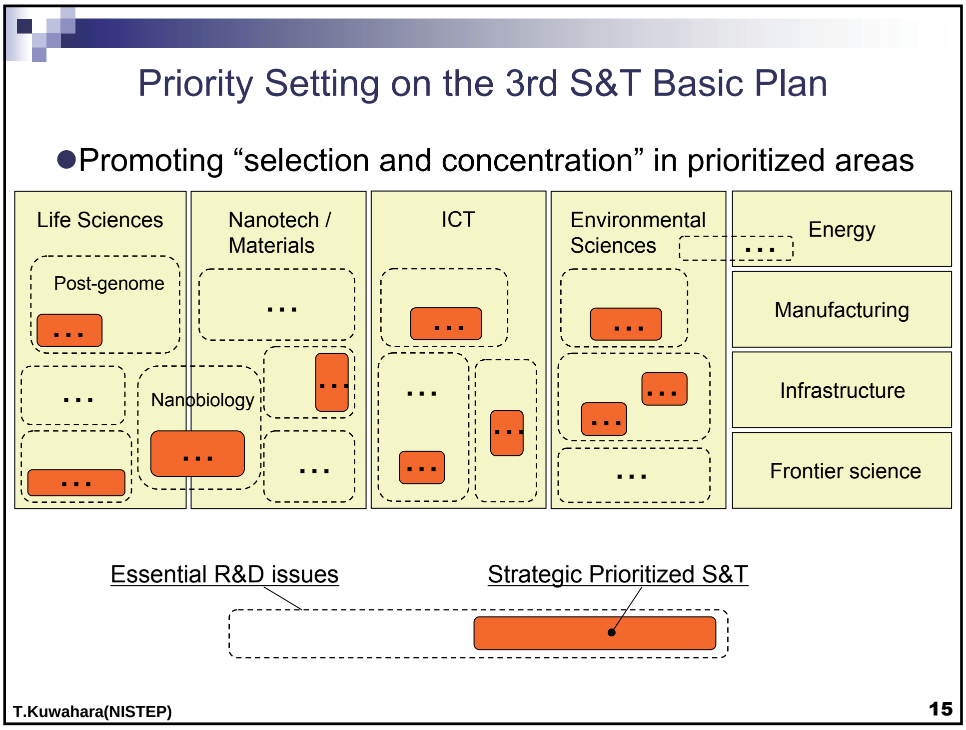
Priority Setting on the 3rd S&T Basic Plan
●Promoting "selection and concentration" in prioritized areas
Life Sciences
Post-genome
Nanobiology
Nanotech / Materials
ICT
Environmental Sciences
Energy
Manufacturing
Infrastructure
Frontier science
Essential R&D issues
Strategic Prioritized S&T
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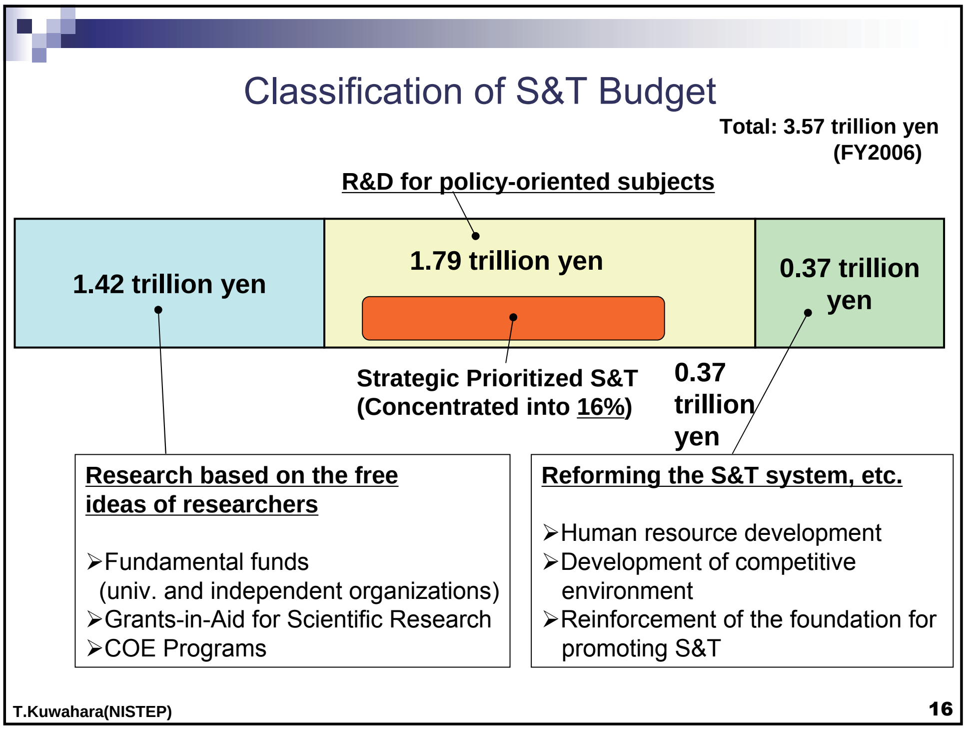
Classification of S&T Budget
Total: 3.57 trillion yen
(FY2006)
R&D for policy-oriented subjects
1.42 trillion yen
1.79 trillion yen
0.37 trillion yen
Strategic Prioritized S&T
(Concentrated into 16%)
0.37 trillion yen
Research based on the free ideas of researchers
➢Fundamental funds
(univ. and independent organizations)
➢Grants-in-Aid for Scientific Research
➢COE Programs
Reforming the S&T system, etc.
➢Human resource development
➢Development of competitive environment
➢Reinforcement of the foundation for promoting S&T
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S&T System Reforms

2. Creating scientific development and persistent innovation

- Create competitive environment
- Strengthen competitiveness of universities
- Strengthen system that creates innovation
- Enforce regional innovation systems and activate regions

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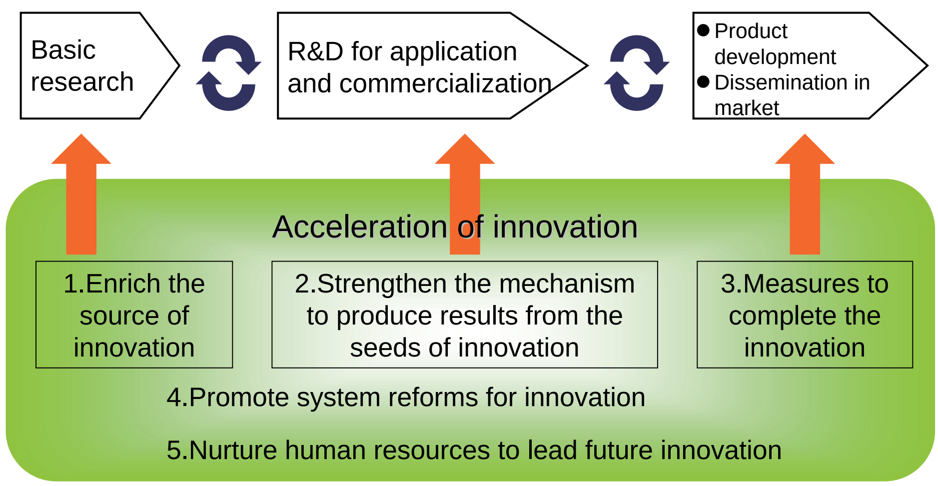
Strategy for Creating Innovation

(CSTP, June 14, 2006)



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1.Enrich the Source of Innovation

- Diversity and continuity of **basic research**
- **World top class research center** with participation of excellent researchers from all over the world
  - Human resource development
  - System reforms for the creation of new academic/S&T fields.
  - A program of MEXT:

    Interdisciplinary/Multidisciplinary area of Lifesciences, Chemistry, Material science, Electronic and information engineering, Mechanical engineering, Physics, and Mathematics (Dec 2006)

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2.Mechanisms to produce results from the seeds of innovation

- **Collaboration among industry, academia and government** beyond borders
  - Establish innovation centers for interdisciplinary areas
- **Regional innovation**
  - Increase the diversity of regional S&T
  - Create innovative local technologies and new industries by taking advantage of regional strength

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3.Measures to Complete Innovation

- For the “**Exit**” of innovation
  - Promotion of the technology through the public procurement
  - International standardization
- Innovation by **venture businesses**
  - Venture capital investment
- Innovation by strengthening **R&D in the private sector**

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Innovation 25 (September 29, 2006)

- Prime Minster Abe’s general policy speech at the opening session of the Diet
- A long-term strategy to create innovative society by 2025
- Multi-disciplinary approach for economic growth

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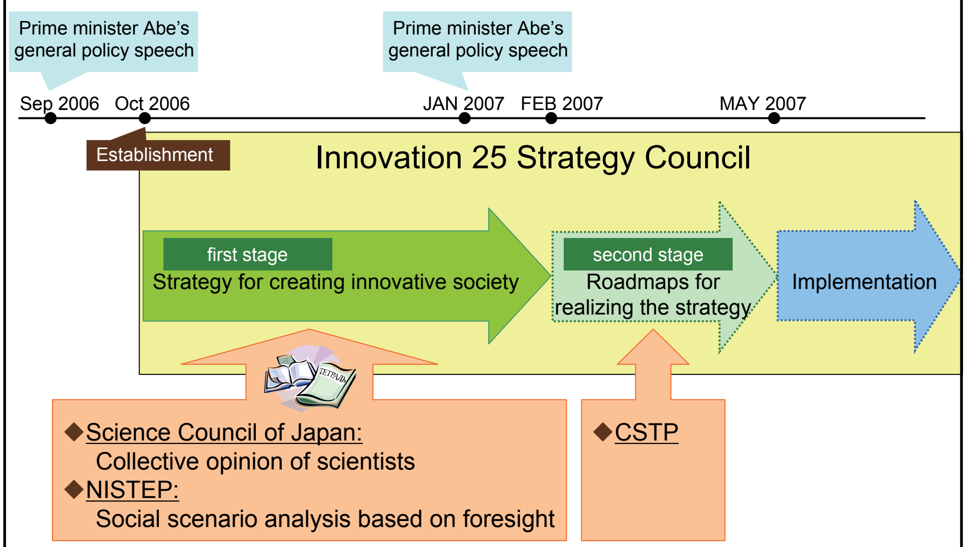
Hot Issues No.2

Time Schedule for “The Innovation 25 Initiative”



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Concluding Remarks :
Implications of Evolving Innovation Policies in Japan

- Promotions of innovation are important political agenda.（The first issue in prime minister Abe’s general policy speech, JAN 2007）

- Academic community plays a certain role in formulating “The Innovation 25 Initiative”.

- Five years of the 3rd S&T Basic Plan will be a period of transition for Japanese national S&T system into innovation and outcome-oriented one.

- The S&T policy has been treated as one of important components of economic policy in the past. However, recognizing the necessity of creating the innovation, decision makers put a more important role to S&T policy. “Policy mix” for innovation will be the next major agenda of Japanese society and economy.

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Thank you.

NISTEP WEB site
http://www.nistep.go.jp/index-e.html

T.Kuwahara(NISTEP) 25

Dr. Yang Presentation

Dr. Hill: The second speaker, Dr. Yang Qiquan, will talk about China's science and technology innovation strategy. Dr. Yang is Deputy Director-General of the National Research Center for Science and Technology for Development in the Ministry of Science and Technology in the People's Republic of China. He is one of the leaders on the Chinese side in the tripartite conversations about international collaboration in science and technology in East Asia, and we are extremely pleased to have him with us. Please welcome Dr. Yang.

Dr. Yang Qiquan, Deputy Director-General, National Research Center for Science and Technology for Development, Ministry of Science and Technology, People's Republic of China: Good afternoon, everyone. [Slide 1] The subject of my speech this afternoon is China's science and technology innovation strategy. As you know, under the guidance and drive of science and technology, the following are clearly evident in the social development of the 21st century. First, knowledge-based society—learning, acquiring and creating new knowledge—will become the means of production, realize dreams and inspire profound changes in social organization and human activity. Second, globalization, international environment. Because of the trend towards globalization, nations without powerful abilities in science and technology innovation will face the risk of being marginalized. Third, economic growth will be featured in sustainable development. The growth types of sustainable-development-supported science and technology innovation will be more than one process of natural changes when a nation reaches a certain phase. It will be a common choice for different nations at different stages of development.

[Slide 2] In the beginning of this century, the Chinese government set up an ambitious target for its economic and social development—to build a well-off society in an all-round way. Realizing this goal means the economic growth rate must be over 7 percent for 40 years from 1980 to 2020, consecutively, even if the investment rate is still kept at about 40 percent as in recent years. The contribution rate of the progress of science and technology must reach 60 percent. [Slide 3] At the same time, China will face greater pressures than other countries, which come from bottlenecks like a large population, scarce energy resources and a deteriorating environment. Only by practicing innovative science and technology can China relieve these pressures.

[Slide 4] Establishing an innovation-oriented nation is a strategic choice for the future development of China. In the past 50 years, many nations have taken different routes to realizing industrialization and modernization. Some nations regard indigenous science and technology innovation as a basic strategy which develops into an ever-growing competitive advantage. The development experience of such nations is a lesson for China.

[Slide 5] As a result, it is necessary for China to take the development route of innovation, which pushes the economic growth type to change fundamentally from factor-driven to innovation-driven, which turns technological innovation into inner motivation for economic and social development and the universal behavior of the whole society. This together with systemic innovation realizes sustainable and coordinated development of the economy and society and provides powerful science and technology support for the goal of building a well-off society in an all-round way.

[Slide 6] From today until the year 2020, the development of science and technology in China will be based on the guiding source of indigenous innovation, the realization of breakthroughs in key fields, continuing support and an eye to the future. As a developing country, China has to fully utilize the current, increasingly open, international environment where we can study and draw on advanced technology from other nations. But we should always base science and technology progress on indigenous innovation. [Slide 7] The core of indigenous innovation lies in improving national innovation capability, which means three things. First, emphasis on original innovation by which to acquire more scientific findings and technological inventions. Second, emphasis on integration innovation to integrate related technologies and form competitive products and industries. Third, emphasis on utilizing international science and technology innovation resources available in an open environment. Also, the promotion of absorption, assimilation and re-innovation based on advanced technology overseas.

[Slide 8] “Breakthroughs in key fields” means China should select key fields concerning the national economy and the people’s livelihood with certain foundations and advantages, then pool strengths to realize that through with a leaping stride. [Slide 9] Supporting development means that due to the pressing demands of the current times, China should exert itself to realize breakthroughs in major key and common technologies to support the sustainable and coordinated development of the economy and society.

[Slide 10] “Guiding the future” means China should as a long-term view deploy pioneering technologies and basic research, create new market needs and foster emerging industries to guide the development of the economy and society in the future. [Slide 11] The goal of science and technology development in the next 50 years for China is to enhance the ability of science and technology to promote economic and social development. Obviously enhance the comprehensive strengths in basic science but also pioneer technical research. To achieve the fruits of science and technology—to be a significant influence in the world, to be an innovation-oriented nation, to be able to provide powerful support for the establishment of a well-off society in an all-round way.

[Slide 12] In accordance with the overall trends of the world’s science and technology development and the strategic goal of China’s modernization, the following should be achieved to meet with future science and technology development. Firstly, the implementation of a batch of special projects on major high-tech strategic products and projects, which will strive to achieve breakthroughs in key technology and make leaping strides in productivity. Secondly, the development of a batch of key technologies, and improved national competitiveness overall. Thirdly, the creation of a scientific base and technology edge and improved ability in conducting consistent innovation to cope with the challenges of the future. Fourthly, deep reform in science and technology mechanisms, to promote the construction of national system of innovation. Thank you very much.

Dr. Hill: Thank you very much Dr. Yang. You have a most challenging job—to plan for the future of a society of one billion people that is growing rapidly and is changing so fast that the rest of the world is amazed. You have to figure out how to keep up with and get ahead of this world. It is a big job and we look forward to watching how that goes for you.

China's Science & Technology Strategy

San Francisco Feb.16 2007

Yang Qiquan
National Research Center For S&T For Development
Beijing China

Features in the 21 century

- (1) the knowledge-based Economy and society.
- (2)the globalization of Economy and Science & Technology
- (3) the economic growth will be featured in sustainable development.

1

Background of Chinese S&T Strategy

- **China's Development Target in 2020:**
  Establishing a well-off society in an all-round way.
  To realize the goal of building a well-off society in an all-round way, then the economic growth rate must be consecutively over 7% for 40 years from 1980 to 2020, which means that even if the investment rate is still kept at about 40% like the performance of recent years, the Contribution Rate of the Progress of Science &Technology must reach 60%.

2

Big Difficulties for the Development

China will face greater pressure than other countries which come from bottlenecks like large population, scarce resource and energy and deteriorating environment, only by practicing sci-and-tech innovation can China relieve these restrictions fundamentally.

3

A Strategic Choice for China

Establishing an innovation-oriented nation is a strategic choice for the future development of China.

In the past 50 years, many nations took different ways in realizing industrialization and modernization.

- Some nations regarded sci-and-tech innovation as the basic strategy and enhanced strength considerably in indigenous innovation, which then formed ever growing competitive advantage.

4

Innovation development road for China

- Push the economic growth type to change fundamentally from factor-driven to innovation-driven
- Turn sci-and-tech innovation into inner motivation for economic & social development and universal behavior of the whole society,
- Innovation together with systematic innovation realizes sustainable and coordinated development of economy and society
- providing powerful sci-and-tech support for the goal of building a well-off society in an all-round way.

5

Basic S&T Strategy of China

- Conducting indigenous innovation
- Concentrating Great S&T Force to Realize breakthroughs in some key fields
- Supporting Economy society development in present
- Guiding future Development in Long Term

6

Indigenous innovation

- The core of indigenous innovation lies in improving national innovation capability, which consists of 3 meanings:
- Firstly, emphasis on original innovation, by which to acquire more scientific findings and technological inventions;
- Secondly, emphasis on integration innovation, by which to integrate related technologies and form competitive products and industries;
- Thirdly, emphasis on utilizing international sci-and-tech innovation resource available in open environment, and promote absorption, assimilation and re-innovation based on introduced overseas advanced technologies.

7

Breakthroughs in key fields

China should select some key fields concerning the national economy and the people's livelihood with certain foundation and advantages, then pool strength to realize breakthroughs and leaping stride.

8

Supporting development in Present

Out of pressing demand of current time, China should exert itself to realize breakthrough in major, key and common technologies, hence to support the sustainable and coordinated development of economy and society.

9

“Guiding the future”

- with a long-term view, China should deploy pioneering technologies and basic research, create new market need and foster emerging industries, hence to guide the development of future economy and society.

10

The goals for S&T development of China

- obviously enhance the ability of sci-and-tech in promoting economic & social development;
- obviously enhance the comprehensive strength in basic science and pioneering technological research;
- obviously enhance the Sci-and-tech strength in national defense;
- achieve a batch of sci-and-tech fruits producing significant influence in the world;
- become an innovation-oriented nation,provide powerful support for the establishment of a well-off society in an all-round way。

11

The Four Missions of China' S&T Development

- To Implement a batch of special projects on major hi-tech strategic products and projects, which strive to gain breakthroughs in key technologies and bring along leaping stride in productivity.
- To develop a batch of key technologies in some key fields, and improve national overall competitiveness.
- To grape scientific base and technological edge, improve ability in conducting consistent innovation to cope with challenges of the future.
- To deepen reform in sci-and-tech mechanism, hence to promote construction of national innovation system.

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Dr. Sungchul Chung Presentation

Dr. Hill: Our third speaker of this part of the session comes to us from Korea. Dr. Sungchul Chung is the President of the Science and Technology Policy Institute of Korea. He is going to talk with us about the evolution of the Korean innovation system. And I must say I will follow this talk with a great interest because some 25 years ago I contributed to a major study of how to improve the Korean innovation system, and it will be interesting to learn how those efforts and many others have played out in this most dynamic part of the world. Dr. Chung, it is a pleasure to welcome you.

Dr. Sungchul Chung, President, Science and Technology Policy Institute (STEPI), Korea: Well, to begin with I would like to thank the Japanese organizers for this wonderful meeting. I salute the NISTEP people for this initiative and organizational effort so that we can have this wonderful meeting at this place.

[Slide 3] What I would like to do this afternoon is to review the process of building technological capability in Korea within the framework of economic development and to assess the Korean innovation system and then try to derive lessons for late-comers based on the Korean experience.

When we started industrialization back in the early 1960s, Korea was in a very, very difficult situation. First of all, geo-politically and geo-economically, Korea was situated in a very, very unfavorable environment; it was a small divided country relying on foreign countries for security and economic survival. It was a resource-poor, densely populated country with a small domestic market and weak technological base. Human resource was the only asset for Korea to use for economic development. So, the Korean Government opted for what they call ‘outward-looking development strategy’ based on human resources and technology.

[Slide 4] The economic situation, as you know, was just miserable. Per capita income in 1961 was only US$87. So, Korea was one of the poorest countries in the world and was facing all the difficulties that poor countries in those days faced. [Slide 5] Science and technology situation: in terms of science and technology Korea was nothing more than a barren land, and from this situation Korea had to start its economic efforts.

[Slide 6] When Korea started its industrialization drive, Korea had to depend totally on foreign technologies, and so its technology policy was very much focused on promoting technological transfer from foreign sources. [Slide 7] However, the promotion of technology transfer faced serious policy constraints, such as shortage of foreign exchanges and strong desire for economic independence. So the government took a very restrictive stance toward direct foreign investment and foreign licensing, and resorted to a policy relying on long-term foreign loans to finance industrial development. The government brought in large-scale foreign loans and allocated them for investment in selected industries, which led to massive importation of foreign capital goods and turn-key plants. Industries later reverse-engineered the imported capital goods for the purpose of acquiring necessary technologies.

[Slide 8] So, in the case of Korea, direct foreign investment and foreign licensing played relatively less an important role in technology transfer in the process of industrialization. Korea relied on its human resources for learning from foreign technologies, transferred through informal channels rather than formal channels. [Slide 9] In addition to the promotion of technology transfer in the early stage of development, the government took various institutional measures to facilitate technology adoption, adaptation and assimilation. As a legal framework, they legislated the Technology Development Promotion Act in 1962, and to promote science and technology development they created the Ministry of Science and Technology in 1967.

To help industries assimilate foreign technologies, they created government research institutions including the Korea Institute of Science and Technology, Korea Research Institute of Chemical Technologies, Korea Institute of Machineries and Metals, Electronic Technology Research Institute, and many others. To supply high level industry engineers and scientists, the government established the Korea Advanced Institute of Science and Technology, which is a specialized graduate-level research and education institution for scientists and engineers.

[Slide 10] By the end of the 1970s Korean economic development had reached such a stage that industrial technology demands became increasingly complex and sophisticated, and so foreign countries became increasingly reluctant to transfer technologies to Korea. The government was responded to these changes by launching the National R&D Program and promoting private industrial R&D. [Slide 11] So, in 1982, the government launched the National R&D Program and started to adopt and implement various policy incentive programs to promote and facilitate industrial R&D. These are some of the actions taken by the government. Government support programs for industrial R&D and innovation at different stages of industrial development in Korea.

[Slide 12] Thanks to the policy, the growth of R&D investment has been very fast. We started from US$700 million back in 1982. In the year 2005, R&D investment reached almost US$25 billion, so Korea became the sixth-largest R&D investor among the OECD countries. We also have gone through tremendous changes in R&D structure. In the beginning, the government explained more than 90% of the total R&D expenditures but beginning in the mid 1980s, the government share declined to almost 25% and today industries account for more than 75% of total R&D activities in Korea. So, Korea's innovation system is heavily dependent on the investment on the private sectors.

[Slide 14] Now, Korea is the fourth largest producer of intellectual properties in the world, following Japan and a few other advanced countries. But the growth has not been smooth at all. When the financial crisis hit the Korean economy, Korean industries responded to the crisis by cutting R&D investment, and R&D personnel at a huge magnitude. In 1997 when the economy was hit by the financial crisis, industries cut R&D expenditure by 14% and they also fired 10% of R&D personnel, a major blow to the Korean innovation system. But it did not take long for the Korean system to recover from the financial crisis. In order to recover from the setback, they promoted investment in small-scale specialized R&D sectors, and also they started promoting very strongly direct foreign investment. This shows the increase of R&D activities in the small and medium industries.

[Slide 15] This chart shows the growth of foreign direct investment in Korea. Still, the investment is much lower when compared with other countries, but the foreign investment has become a lot more important than it used to be. I think direct foreign investment is more important in Korea than it is in Japan today.

[Slide 16] Now, what are the factors behind such a growth? We can think of two important factors. One is supply-side factors and the other one is demand-side factors. [Slide 17] On demand-side factors, we can think of the competition policy, outward looking development strategy and many others which have stimulated demand for R&D activity in Korea. Supply-side factors include human resources—Korea was very well prepared in that respect—and financial resources: because of the rapid economic growth Korea could finance the growing demand for R&D investment. And also in addition to that, the government provided many support programs in order to promote and facilitate R&D and innovation activities in private sectors. Those supply factors and demand factors got together and have made the growth possible in Korea.

[Slide 18] What are the key factors that influenced the Korean innovation system? Firstly we can say that the outward looking development strategy of government has played a very important role in determining the characteristics of the Korean innovation system today and then the government policy toward foreign direct investment and technology transfer. Government industrial policy, human resources, and government-led development of S&T infrastructure; these factors have influenced the Korean innovation system and determined the characteristics of the systems.

[Slide 19] What are the strengths and weaknesses of the Korean system? First, the strength, dynamism fuelled by the strong commitment of the government and private industries' efforts for competitiveness; domestic firm's exposure to international markets that provide pressure for R&D; and Chaebol system, its ability to invest in long term risky projects. And human resources. These are some of the strengths of the Korean innovation system. Because of these strengths, Korea has been able to make tremendous achievements in terms of publications, intellectual property rights and others, and Korea has been able to obtain technological leadership in selected areas of technology.

[Slide 20] But there are weaknesses too. The most serious weakness of the Korean system is the imbalance inherent in the Korean system. Firstly, the imbalance between basic scientific research and technological development. The imbalance between large firms and small, medium enterprises, and imbalance that exists among regions. These are some of the imbalances which are inherent in the Korean system. Another weakness is Korean system's excessive reliance on private investment. Because it relies for more than 75% of R&D activities on private sector, it is very, very vulnerable to changes in markets, just as what happened back in 1997 when the financial crisis hit the Korean economy.

Another weakness is the weak industry-science relationship. That means the results of scientific activities have not been translated quickly enough into economic values. Lastly, we can think of another weakness, which is insufficient internationalization of the Korean system. International R&D activity is insufficient; we do not have sufficient direct foreign investment in R&D, and we do not have sufficient co-invention et cetera, et cetera.

[Slide 21] Are there any lessons for late-comers from the Korean experiences? There are some, I think. Firstly, market competition is the very source of motivation for innovation. Strong pressure for technological competitiveness coming from market should be considered the most important factor in promoting innovation. We would like to emphasize the effectiveness of the outward-looking development strategy for small, open economies which lack resources and strong technological basis. Another lesson is that human resources are the key to learning. Without human resource, which are well educated, it is very, very difficult to learn foreign technologies in a short period. So, human resource is the key to development.

Third, the government can play effectively the role of facilitator and promoter at the early stage of development. But the role should decline as the development continues on. Lastly, based on the current experiences, we can say the efficiency of the national innovation system hinges very much upon industry-science relationship and this is very important factor for late-comers to consider in designing their strategy for innovation system. Thank you very much.

Evolution of the Korean Innovation System

February, 2007

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Structure of the presentation

I. Objectives of the Presentation

II. Initial Setting: Where Korea Started

III. Technology Learning for Industrialization

IV. How Korea Built up an Indigenous R&D System

V. Key Characteristics of KIS

VI. Lessons for Late-comers

I. Objectives of the Presentation

- To overview the process of building technological capability within the framework of economic development in Korea
- To assess the Korean innovation system
- To derive lessons for late-comers

2

II. Initial Setting: Where Korea Started

- Geo-political and geo-economic conditions
  - A small divided country relying on foreign countries for security
  - A resource-pour, densely populated country with small domestic market and weak technological base : Human resource was the only asset for economic development
  - ⇨ Outward-looking development strategy based on human resources and technology

3

❑ Economic situation (1961)

- ❖ GNP : $ 2.3 billion (1980 prices), GNP P/C : $87
- ❖ Exports : $55 million, Imports : $ 390 million
- ❖ Share of manufacturing in GNP : 15%
- ❖ Unemployment rate : 22.3%
- ⇨ One of the poorest counties in the world

4

❑ S&T situation

- ❖ R&D manpower (1969) : 5,337
- ❖ R&D investment (1963) : $ 9.5 million (Gov't: $ 9.2 million)
- ❖ R&D organization : National Defence R&D Institute (1953) Korea Atomic Energy Research Institute (1959)
- ⇨ A barren land as far as S&T is concerned

5

III. Technology Learning for Industrialization

- Government's drive for the development of light industries and heavy chemical industries for import substitution and export-expansion in the 1960s and 70s generated enormous demand for technologies that were not available from domestic sources.
- The government responded by promoting inward transfer of technologies, and developing domestic absorptive capacity to digest, assimilate and improve upon the transferred technologies

6

- However, the promotion of technology transfer faced serious policy constraints, such as shortage of foreign exchanges and strong desire for economic independence
- So, the government took a very restrictive stance toward DFI and FL, and resorted to a policy relying on long-term foreign loans to finance industrial investment : "Gov't brought in large-scale foreign loans and allocated them for investments in selected industries, which led to massive importation of foreign capital goods and turn-key plant. Industries later reverse-engineered the imported capital goods for the purpose of acquiring the necessary technologies."

7

❑ To such a government policy, private industries responded in various ways

❖ Light industries (shoes, clothing, textile…)

⇨ Rely on OEM production arrangements

❖ Chemical industries

⇨ Resort to turn key-plant importation with technical training

❖ Electric and machineries

⇨ Relatively more reliant on FL

> ➢ DFI and FL played relatively less important role in TT in the process of industrialization of Korea.
> Korea relied on its HR for learning from foreign technologies transferred through informal channels.

8

❑ In addition to the promotion of technology transfer, the government took various institutional measures to facilitate technology adoption, and assimilation

❖ As a legal framework
- ✓ Technology Development Promotion Act

❖ To promote S&T development
- ✓ Ministry of Science and Technology(MOST, 1967)

❖ To help industries assimilate foreign technologies
- ✓ Korea Institute of Science and Technology(KIST, 1966)
- ✓ Korea Research Institute of Chemical Technology
- ✓ Korea Institute of Machinery and Metals
- ✓ Electronic Technology Research Institute

❖ To supply high-level industrial engineers and scientists
- ✓ Korea Advanced Institute of Science and Technology (KAIST, 1972)

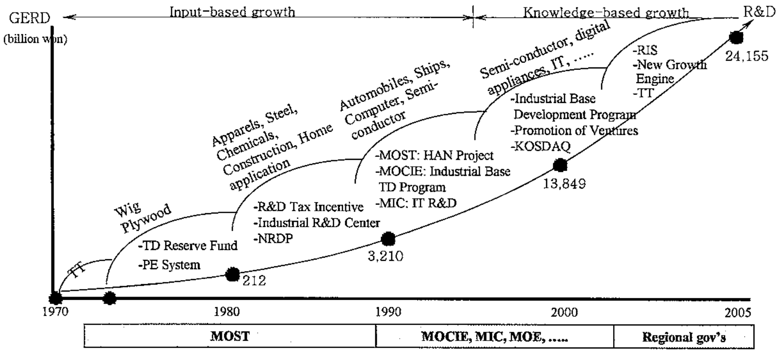
9

IV. How Korea Built up an Indigenous R&D System

- ❑ By the end of the 1970s, Korean economic development had reached such a stage that industrial technology demands became increasingly complex and sophisticated and also that foreign countries became increasingly reluctant to transfer technologies to Korea
- ❑ The government responded by launching the NRDP and promoting private industrial R&D
  - ⇨NRDP in 1982
  - ⇨Policy incentives for industrial R&D : financial, fiscal, tax, etc.

10

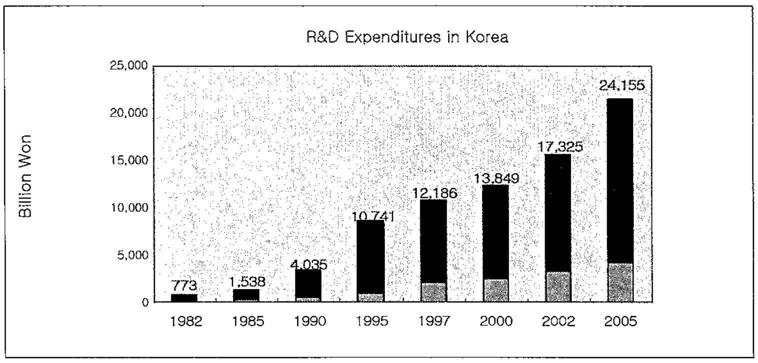
- ❑ Policy Incentives for Private Innovation



	MOST		MOCIE, MIC, MOE, …..	Regional gov's
Tax	Technology Development Reserve Fund('72)	R&D Tax Incentive('81) Tariff Debation for R&D Equipment('82)		Special Tax Incentives for Foreign Engineers('02)
Financial	Korea Technology Promotion Corp.('74)	KTB('82)	- Law for the Promotion of Start-ups('91) - Financial Support for Industrial Development('86) - S&T Promotion Fund('93) - IT Promotion Fund('93)	⋮
R&D Subsidies		NRDP('82)	-Industrial Base Technology Development Program('87)	-New Growth Industries ('03) - Regional Cluster Program ('03) ⋮

11

❑ Growth of R&D investment

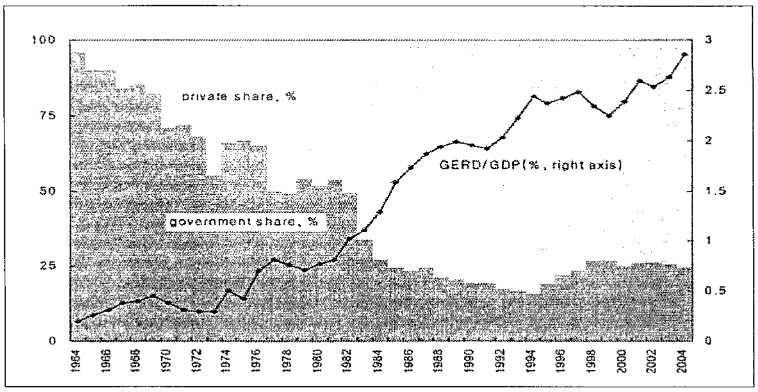


Note: Upper portion of the bar refers to industry contribution, and the lower parts that of the government.

⇨6th largest R&D investor among OECD countries

12

❑ Trend of Korea's R&D Expenditures



Source: Ministry of Science and Technology, Republic of Korea

⇨Private industries account for over 75% of the GERD

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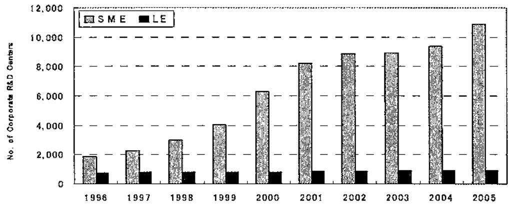
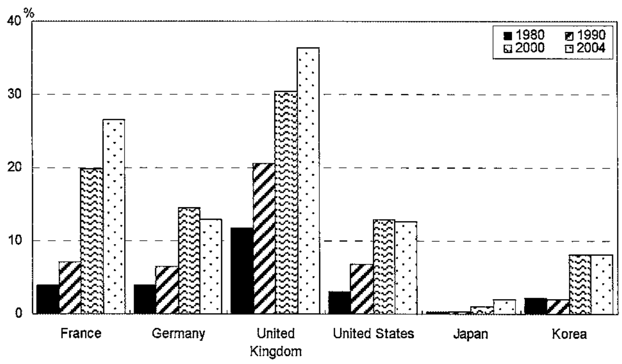
The Impacts of Economic Crisis on R&D

- The impacts of the economic crisis of 1997
  - Cut in R&D expenditures by LEs : 14%
  - Cut in R&D personnel : 10%
- Recovery
  - Growth of small-scale, specialized R&D centers and/or technology-based firms : SME's growth in R&D

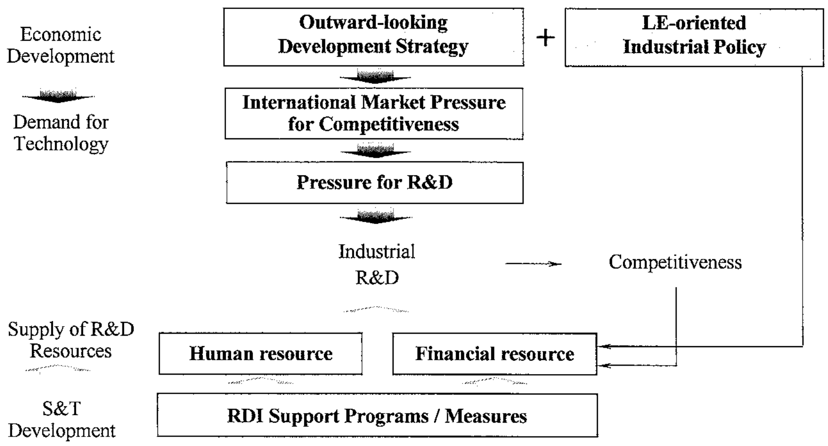


	R&D expenditure, in billion won (and as percentage of sales)			Researchers (doctoral level)		
	1997	2000	2003	1997	2000	2003
SMEs	1,090.2 (2.82)	2,106.4 (3.14)	3,425.4 (3.57)	17,703 (474)	36,494 (1,543)	52,332 (2,291)
Large enterprises	7,755.1 (2.07)	8,148.2 (1.81)	11,084.2 (2.05)	56,990 (3,613)	57,839 (3,878)	71,698 (5,562)

- Promotion of inward DFI
  - ✓ Role of FDI Companies



❑ Factors behind the growth



16

❖ Demand side : Outward looking development → export-orientation of industries → pressure from international market for technological competitiveness → increased demand for R&D investment

❖ Supply side
- o Financial resources : Large-firm-oriented industrial development → chaebol system → increased abilities of private industries to finance long-term, risky R&D projects
- o Human resource : Korea prepared itself well for R&D by investing heavily in education and HRD

17

V. Key Characteristics of KIS

- Key factors that influenced the KIS
  - Outward-looking development strategy ⇨Pressure for R&D investment
  - Government policy toward FDI and TT ⇨Focus on indigenous R&D
  - Government-led industrial development
    - Industry-targeting ⇨Inter-industry R&D imbalance
    - Favoring large enterprises ⇨R&D system biased for large firms/Financial capability to invest in R&D
    - S&T for industrialization ⇨R&D system biased toward technology development
  - Rich pool of well educate HRST ⇨ High absorptive capacity
  - Government-led development of S&T infrastructure ⇨ Relative importance of GRIs

18

- Strength and weakness
  - Strength
  - ⇨ Dynamism fuelled by the strong commitment of the government and private industries' efforts for competitiveness
  - ⇨ Domestic firms' exposure to international markets:pressure for R&D
  - ⇨ Chaebol system: ability to invest in long-term risky projects
  - ⇨ Human resources

> ➢ Growing scientific achievements: publications, IPR, etc.
> ➢ Attained technological leadership in selected areas of technology

19

❖ Weakness

⇨ Imbalances in innovation system

1. Basic scientific research vs technological development
2. Large firms vs SMEs
3. Regional concentration

⇨ Excessive reliance on private investment: vulnerable to changes in markets

⇨ Weak industry-science relationship

⇨ Insufficient internationalization: insufficient R&D DFI, international co-invention, etc.

20

VI. Lessons for late-comers

❑ Lessons for late-comers

❖ Market competition is the very source of motivation for innovation

⇨ Pressure for technological competitiveness

⇨ Effectiveness of the outward-looking development strategy for small economies

❖ Human resource is the key to learning

❖ Government can play effectively the role of facilitator and promoter at the early stage of development

❖ The efficiency of an NIS hinges very much upon ISR

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Thank you!

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Q&A Session

Dr. Hill: We have about 15 minutes for questions or very short speeches from the floor. I do not encourage long speeches from the floor, but a brief speech setting up a question is okay. Please raise your hand if you have a question. When I recognize you, please identify yourself and direct your question to one or more of the speakers. I hope that the questions and answers will be frank and open, in the best spirit of international conversation. Are there questions from the audience?

Q: I would like to know the current situation of joint research between universities and industry in Japan.

Mr. Kuwahara: As for joint research between university and industry, the Japanese government takes the same measures as the United States. We introduced Japanese version of "Bayh-Dole Act" several years ago. Traditionally, Japanese national university researchers had unofficial relations with industry people. But the situation has changed, and many contract-based joint researches are now being conducted. The expansion of university-industry collaborations are positively accepted by university researchers and industry people.

Q: Many Japanese firms have come to U.S. universities for collaborations. My question is whether that is changing, whether there is a greater tendency for Japanese firms to work with universities in Japan, and is there a government incentive to do that?

Mr. Kuwahara: We hope that Japanese industry pays more attention to Japanese universities. The government gives some kind of supporting aid. For example, if some universities carry out joint research with industry, the government provides funds for the joint program. But I am afraid that the majority of Japanese firms are still looking at U.S. universities.

Q: How does the protection of intellectual property play into their competitive strategy?

Dr. Chung: We conducted the study on the impact of intellectual property right or the innovation activity in Korean industries several years ago and what we found was that the legislative actions to strengthen the protection of intellectual property rights have been making positive contribution to the innovative activities in the private sectors. We also found that such legislative actions might have different impact on private sectors depending on the economic development stages. In the earlier stages when there are not much to protect within the private sectors, sometimes the legal strengthening of the protection of intellectual property rights may work as a barrier to technology transfer within the private sectors but once they begin to have something to protect, they tend to respond very, very sensitively to the legal changes. That was what we found so I think that at this time, now presently, the strengthening of the protection of intellectual property right in Korea has been making a lot of positive impact on the innovation activities.

Dr. Hill: Dr. Yang, would you like to address that question for the case of China?

Dr. Yang: I agree with Dr. Chung. This problem depends on the different development stages. At first China used a lot of imported technology and the impact of international technology had a great influence on China's technology industries. But now more and more Chinese companies create their own technology. They also use technology from abroad, but they pay much attention to the patents of foreign companies.

Mr. Kuwahara: As for intellectual property, Japanese situation is the same as Korea and China that were already mentioned. The government initiated the discussion of intellectual property around 10 years ago. To promote measures for the protection of intellectual property, Basic Law on Intellectual Property enacted several years ago and the government established the Intellectual Property Policy Headquarters in the Cabinet. For example, the Intellectual Property High Court started operating as a court specializing in intellectual property cases and the Japanese patent office is now strengthening its capability of the evaluation and also is fostering its human resources.

Q: My understanding is that part of the success of the Korean model is that the technology policy you described actually created shared prosperity within Korea by generating lots and lots of well-paying jobs in manufacturing in the industries that were being supported. So all of Korea benefited and a big middle class developed.
My question is actually about China, where a very similar strategy seems to be leading into a big divide between the areas along the coast where the manufacturing jobs are being created and the western part of China which is being largely left behind. Now, obviously the two countries are quite different in size, and it is easier with an export-orientated strategy to have all Koreans share in prosperity. But I am wondering what the plans are in China to ensure that some of the benefits that are being generated in the economy are shared broadly across the country.

Dr. Yang: Thank you for your question. Just as you mentioned, China is a big country and economic output in China is imbalanced in different areas. In the coastal part of China the economy developed very quickly, but in the southwest it developed not so quickly. Starting from the beginning of the 1980s, most foreign investment had been centered in the east. So in the east the economies of about 10 provinces developed very quickly. But at the end of the 20th century and the beginning of this century the Chinese government has set up a new economic development strategy to promote the movement of foreign and domestic investment from the east to the west. They have set up many policies to encourage researchers and some investment to move to the west. In the last five years I think things have changed gradually. I think during the next 15 years the Chinese government will make a plan to further promote this development chain. They now encourage young people especially, some graduate university students, to work in the west and give some financial support. I think in the future the western part of China will increase more quickly than the eastern part. This is one kind of Chinese development strategy.

Dr. Hill: Thank you. I cannot help but reflect on the history of the United States, in which two issues that were asked about characterized my country. One is that in the 19th century Americans paid little attention to European intellectual property. “Yankee ingenuity” meant, in part, skillful copying of European patented products and technologies. The second is that the United States had a very deep problem with the regional imbalance in the economic development of the north and south. It took us a couple of centuries to address the second issue, which is still not completely sorted out. So these kinds of problems seem somewhat universal. Those of us who think we have solved some these problems should not be too impatient with others who are still addressing them in their own situations.

Q: I would like to ask about the demographics of the science and engineering (S&E) workforce in each of the countries. What are the trends?

Dr. Chung: We are getting near to a very major demographic transformation. The birth rate started to decline very rapidly. I think the birth rate in Korea is the lowest in the world today, and some years after from now we will face a drastic decline in cohort who have to go to school. But up until now it has not had such a direct impact yet. In Korea actually the proportion of students who go to science and engineering at college level is not determined by demand but by supply, because there are enrolment codes at each university, and since demand has always exceeded supply at university, the universities never had any problem in filling the enrolment so far. But now we are seeing kind of symptoms that the situation is becoming different and reversed. Some universities suffer from declining applicants and some universities are not able to fill the enrolment quotas given to them. So within some years I think we will undergo serious changes in college enrolment and in particular in science and technology due to the demographic changes. But so far we have not any changes.

Dr. Yang: Yes, I will give you a case in China. There are 1.3 billion people living in the country. Even though we have a one-child policy I think population is still a problem in China. For the young students, I do not know why, they like to study science and engineering. My parents and I think other Chinese parents tell their children that if they study mathematics, chemistry and physics well they can find a job anywhere. So Chinese students like to choose science and engineering subjects in the universities. I know it is different from other developed countries, for example the United States and Japan. But in the future maybe this will change. But so far students like to study science and engineering.

Mr. Kuwahara: Japan has a big problem of how to foster enough young researchers. Our demographic is aging very rapidly, and the percentage of young people is decreasing. The government is now trying to invite more and more female researchers into the science and technology arena. In the case of Japan not so many young women go to a science and engineering schools and get into science and technology fields. So this could be one possible solution. Another solution, as I mentioned in my presentation, is to invite good foreign researchers to Japan.

Dr. Hill: Please join me in thanking our first three speakers for very, very interesting presentations and a good Q&A session. We will now take a five-minute break to bring up the next three speakers. Please do not leave.

Session 2

"National Innovation Strategies in the East Asia: Policy Analyses and Evaluation"

Mr. Tomizawa Presentation

Dr. Hill: For this second part of the session we are going to focus on some specific questions about the policies that we heard about earlier, including a particular focus on the evaluation of some of the policies. I know many of the Americans in the audience are deeply involved in the field of evaluation and will be anxious to hear about some of the new and interesting ways that evaluation is being carried out in the three countries. Our first speaker of the second section is Mr. Hiroyuki Tomizawa, again from NISTEP. So, welcome, and we look forward to your talk.

Mr. Hiroyuki Tomizawa, Director of Research Unit for S&T Analysis and Indicators, NISTEP: Today I would like to speak about the Japanese science and technology system reform and its effects. In particular I am going to discuss the changes that have happened in science and technology activities since 1996 when the S&T Basic Plan started. In addition to that I will pose the question whether Japanese innovation capabilities have really been improved.

[Slide 1] NISTEP has worked on various evaluative analyses in relation to science and technology policies. Here I introduce some analysis from them that illustrate important historical change. This is an outline of my presentation. I explain the analysis results in three parts like this. [Slide 2] This is about the background and the point of the analysis, but I would like to omit this slide because of time shortage.

[Slide 3] First of all you see the trend of the growth in the number of Japan's scientific papers. The term "Japan's scientific papers" is defined as papers written by researchers who belong to organizations located in Japan. As you see, Japan's scientific papers increased sharply both in number and share from the 1980s to the late 1990s. But then from the late 1990s the increase rate has slowed down. It is ironic that this slowdown began at the same time as the influence of the S&T Basic Plan became clear.

We cannot say any definite conclusion only from these results, but here I would like to offer some possible reasons. In the first place the number of papers cannot increase forever, as Japan has already come to the second largest after the United States in science paper publication. It might be that Japan is moving into a new stage or a natural slowdown. Secondly, in the 1980s R&D expenditure and the number of researchers in Japan increased almost steadily, but the growth rate has slowed down since the late 1990s.

By the way, the Basic Plan did not bring an increase in R&D investment. Even in Japan many people misunderstand this fact. Rather than that, it is correct to say that the S&T Basic Plan prevents the government R&D investment level from declining. Likewise, they may have minimized the slow down in scientific paper publication.

[Slide 4] Not only Japan but also other major countries' publication trends: this graph illustrates the growth rates of paper publication by five years since the 1980s. Japan's average growth rate was over 5% in the 1980s and in the early 1990s, positioned in the highest growth rate group among advanced industrial countries. But in the late 1990s the growth rate fell to 2.8%. In the first half of 2000 it dropped to 1.4%, the lowest among the countries in this graph. In contrast, China and Korea have achieved striking growth rates in the world. This trend looks set to continue for some time.

[Slide 5] Apart from the analysis mentioned just now, we carried out various quantitative analyses. Since I have no time to discuss all the results, here I will give only the significant observations. First, in Japan the high growth era of scientific paper publication seems to be nearing an end. The S&T Basic Plan may delay the coming of the low-growth era, but quantitative growth could be expected no more as long as resources are limited. Therefore in order to expand Japan's innovation capability it is essential to make a quality improvement.

[Slide 6] The next part is observation of structural change in the Japanese research system. First of all, the breakdown in the number of papers by sector is shown in this graph, in order to get an overview of Japan's national research system. The vertical axis in this graph indicates share in all papers recorded in the SCI database. Regarding the number of papers by sector, universities accounted for the most, but universities' share has not been increasing at all since 1999.

[Slide 7] Then let us look at the structure of sectors from a slightly different viewpoint. These graphs are about breakdown of Japan's scientific papers by sector and by citation frequency rank. The left graph, A, shows data on full papers, while B shows data on the top 10% of the most frequently cited papers. In both two graphs the length of bars represent Japan's share in the world. Comparing the two graphs, the bars of the right graph are shorter than those of the left, indicating Japan's share is relatively small in influential papers. However, interestingly there is a reverse tendency in terms of semi-public institutes, which is indicated by the red part in this graph. That is, the share of semi-public sector is bigger in the large graph. In other words, this sector has a relatively large presence in terms of frequently cited papers, and its share is increasing. Looking into the detail, Riken and JST contributed to the increase of papers published by semi-public institutes. These two organizations have led in system and management reform, with a strong financial background. Their high performance suggests the effectiveness of the policies.

[Slide 8] Let us see other countries' situations. This graph is paper shares of countries by citation frequency rank. These bars are in descending order of citation frequency rank from left to right for each country. For example the United States has the highest share in the top-10% of highly cited publications. This tendency is also observed with regard to England, Germany, France, and Canada. On the contrary, Japan, China, and Korea are the highest in the low-cited publications. I can say that this is the catch-up phase of scientific research. In regards to China and Korea this interpretation would be fair because in both countries rapid growth of paper publication began rather recently. But Japan is in second position in the world ranking of paper publication. In view of that it is possible that Japan is still immature in excellence of science research. Quality improvement of papers as research output is not an easy task. It will require reforming the research system and developing capable human resources.

[Slide 9] I analyzed the conditions under which high-quality papers are produced. Since the concept of paper quality is too ambiguous, here I decided the number of high quality scientific papers as an indicator of paper quality. This graph shows the relation between the amount of research grant and the number of highly cited papers of universities in Japan. The horizontal axis is the total amount of grant-in-aid for scientific research, with the major government fund of scientific research in Japan. The vertical axis is the number of the top 10% of the most frequently cited papers. In order to prevent apparent correlation due to the size of universities, those values were standardized by dividing by the number of faculties. A clear correlation with the fund is recognized from this figure. This data seems to suggest that funding by a competitive process is in correlation with production of highly-cited papers. When we analyze not only this but other several data, all the results suggested correlation between the fund and highly cited papers.

[Slide 10] Further than that, we gained the results that the number of doctoral students also affects paper publication. But increases of doctor students seem to contribute to the growth of low-cited papers. This graph shows such a situation. The horizontal axis indicates the number of low-cited papers. This analysis corresponds to the historical trend that in the 1990s the number of doctoral students increased considerably, and paper production also increased.

[Slide 11] As long as the consideration a number of scientific papers are produced in universities, raising the research level of universities is critical for higher research standards in Japan. For that purpose we have two possible approaches. One is trying to raise the level of the Japanese investment system as a whole, and another is focusing on top-ranking universities. In this regard Japanese policymakers have already decided the course to take by choosing the latter approach. They set the target of boosting up 30 or so universities to world class in various fields. Therefore allocation of research resources will more and more be based on selection and concentration strategy. But seeing this graph we know that concentration of research capability has already been taking place. This graph is the number of papers published by each university, showing that the top 10 or so of all universities occupy almost half of the papers produced by all universities in Japan. Considering this situation we have to examine policies for middle or low-ranking universities.

[Slide 12] Next we move to the third part, the analysis results I mentioned until now showed that the structural change in the Japanese research system is processing and the research performance is improving. But it is necessary to make sure that these changes are really the result of policy, and to identify specific effects of measures of the plans. Here I would like to introduce to you the data that could meet such needs to some extent. It is a questionnaire survey we conducted two years ago, which targeted authors of top 10 frequently cited papers. We call them “top researchers.” This survey aimed to find out the characteristics of excellent researchers and to know the S&T Basic Plan’s effect on the Japanese R&D system. Additionally, we asked the top researchers how the research environment has changed. As this survey was for authors of highly-cited papers it is possible to identify under what environment researchers can produce influential research outputs.

[Slide 13] This graph is the top researchers’ answer to 22 questionnaire items about the research environment. For each item we asked about the situation before 1996 and at the end of 2004, when this survey was conducted. By comparing these answers we could grasp the change in the research environment. In this graph this side indicates the situation before the Basic Plan, and the other side indicates the situation in 2004. Top researchers answered that the environment has been improved on 21 items of all 22 items. But there is one item they think the situation became worse; it is an item about research time. This means it is getting difficult for top researchers to save research time, because of increasing office work. So in general the research environment was positively assessed, except this one item. But you should not overlook the fact that there are 17 items which are valued as insufficient, indicated on the left hand side, means that it is getting difficult for top researchers. This means that the environment has become better than before, but not sufficient yet. It seems that highly raised items are mainly about research funds, facilities, and equipment. On the other hands human resources-related items were just as insufficient relatively.

[Slide 16] Top researchers' answers can be summarized as follows. Top researchers feel that in the past 10 years their research environment has been improved generally, and this change contributes to influential research results. This suggests science and technology policies like basic plans are producing some effects. However, top researchers also think that their research environment is not sufficient enough, requiring continuous improvement. Furthermore, several problems have come to the surface from answers of top researchers. For example, human resources are still less developed. Resource allocation for research is not adequate. Some researchers are anxious for this regard to long-term fundamental research.

[Slide 17] At last, we come to the final point. I have been talking about science research quality enhancement, or system improvement. Then how will these things be involved with the Japanese innovation capability? Of course, as long as innovation is promoted mainly by the industrial sector the contribution of science research by universities and public research institutes will be limited. But I think science research is long-term fundamentals for innovation. As we learned from the history of these 30 years, the difficulty is not in short-term innovation itself, but in keeping it. Against a backdrop of this history, the science research system represented by the university sector has not fulfilled its potential for a long time, and still has various difficult problems. While it has been reformed little by little, more essential quality improvement has not happened yet. It depends on how much we will devote ourselves to it in the future. That is all. Thank you for your attention.

Mr. Hill: Thank you very much, Mr. Tomizawa. That is just a little sample of many, many other kinds of indicators and data that have been collected at NISTEP over the last several years. Your talk includes some interesting ideas here for the U.S. to consider.

Recent Japan's S&T System Reforms and Innovative Capabilities:

An Evaluative Analysis

National Innovation Strategies in the East Asian Region
2007 AAAS Annual Meeting
15-19 February • San Francisco

Hiroyuki TOMIZAWA
National Institute of Science and Technology Policy [NISTEP], Japan

Outline

- Background and the viewpoint

I. Quantitative trend of research output
   - Did S&T Basic Plans increase research output quantitatively ?

II. Structural change of the national research system
   - How were the results of system reform policy ?
   - What effects the Basic Plans had on Japan's research system ?

III. Opinion of researchers
   - Which policy contributes to excellent research activities ?

1

Background and the viewpoint of the analysis

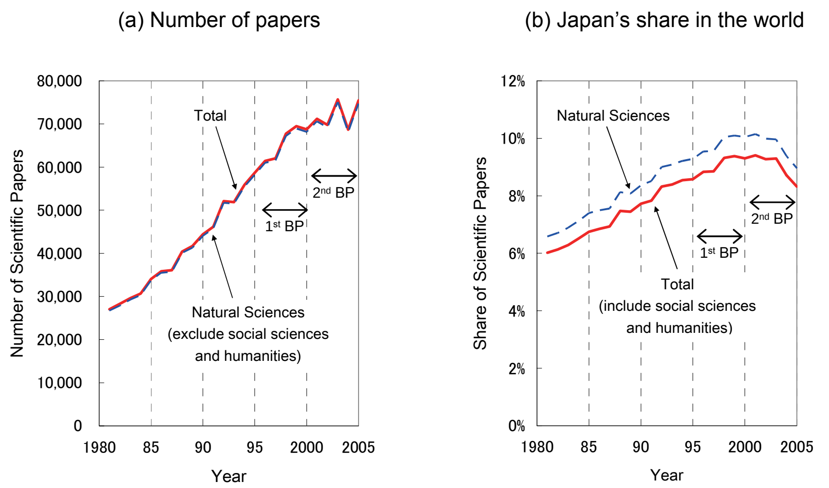
- Background
  - Japan's position in history
  - S&T Basic Plans
  - Global competition
    - Rapid growth of Asian countries outside of Japan

- Viewpoint of evaluative analysis
  - For assessment policies such as:
    - Increase of S&T investment
    - System reform
    - Prioritization of research area

2

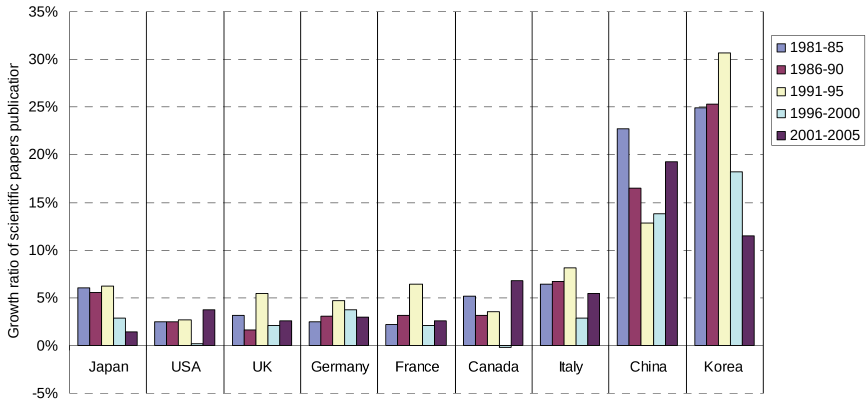
I. Quantitative analysis on research output

Trends of Japan's scientific paper publication



3

Growth ratios of scientific papers publications in major countries

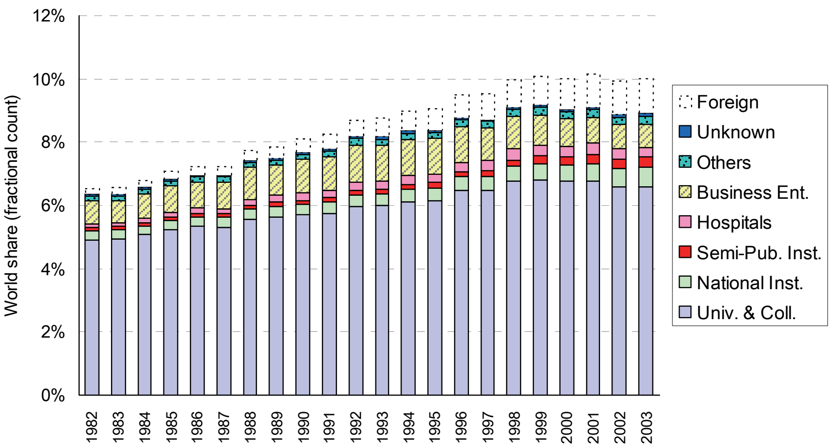


Some suggestions of quantitative analysis

- Japan's position in history
  - End of ***high-growth era*** in science
- Research output has increased corresponds to large investment ?
  - S&T Basic Plans that prevented governmental R&D investment level from decline
  - Likewise, they might have minimized the slow-down of scientific paper publication
- From quantity to quality
  - Improvement of system for knowledge production
  - Quality of human resources are essential

II. Structural analysis on research system

Trend of scientific paper publication by sector



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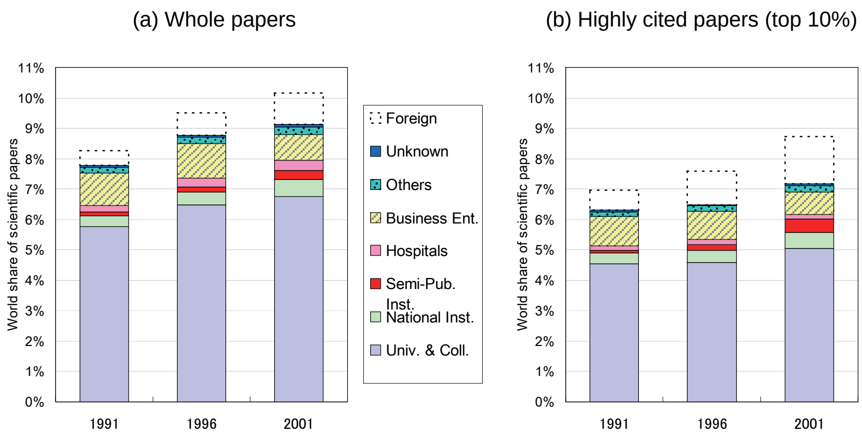
II. Structural analysis on research system

Trend of publication by citation rank and by sector

- Semi-public institutes has the strength in producing highly cited papers

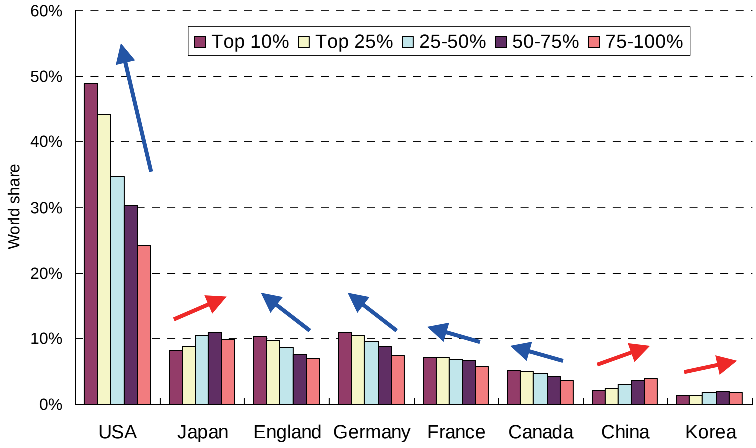


Note: Inter-sectoral co-authored papers are counted in fractional base.
Source: Authors' calculation based on *Science Citation Index*

7

II. Structural analysis on research system

Countries' shares of publication by citation rank (2000)

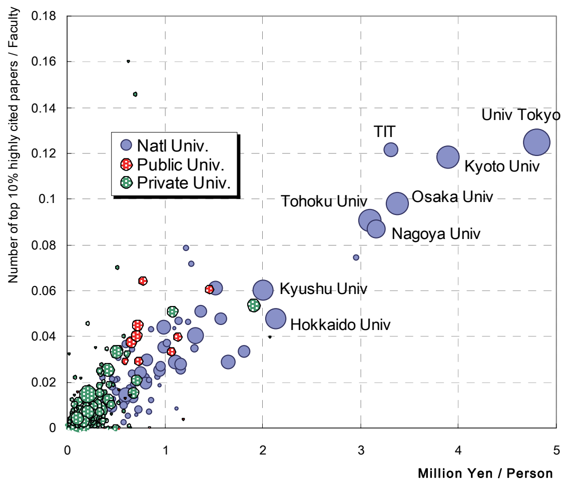


Source: Authors' calculation based on *Science Citation Index*

8

II. Structural analysis on research system

Relation between the total amount of scientific research grant and the number of the influential papers



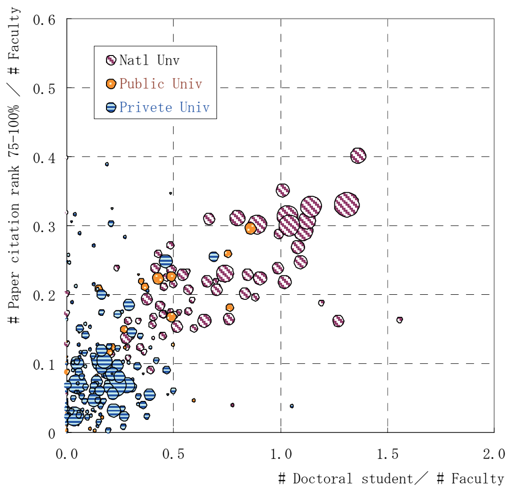
Grant-in-Aid Sci. Res. Per Faculty

- Removed apparent correlation due to the size of universities
- A clear correlation is recognizable from the graph
- The correlation coefficient was 0.76 (p<0.01).

9

II. Structural analysis on research system

Relation between the number of doctoral students and the number of the low cited papers



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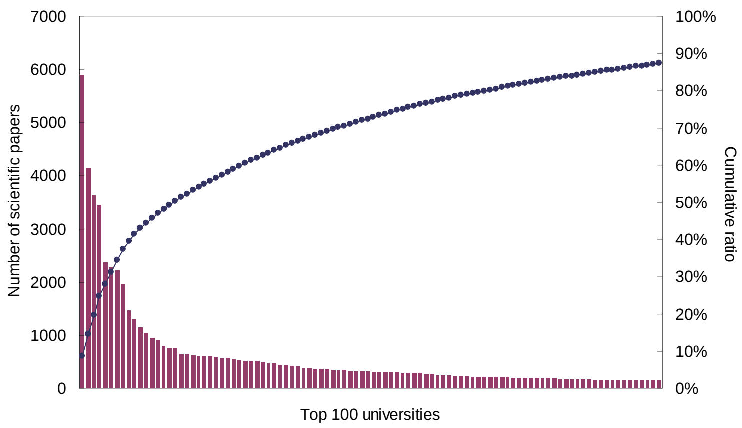
II. Structural analysis on research system

Distribution of number of scientific papers publication by each university



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III. Opinions of researchers

Japanese research system has improved ?

- Questionnaire survey to “top-researcher”
  - Top-researcher ⇔ Authors of top 10% frequently cited papers
    - Top 10% frequently cited papers of Japan are about 4,500
    - Sent questionnaire to authors of 1,500 papers
    - 868 authors responded
- Aims of the survey
  - Clarifying characteristics of excellent research activities
  - Clarifying effects of S&T Basic Plans on Japan’s research system
  - Researchers opinions of change of research environment

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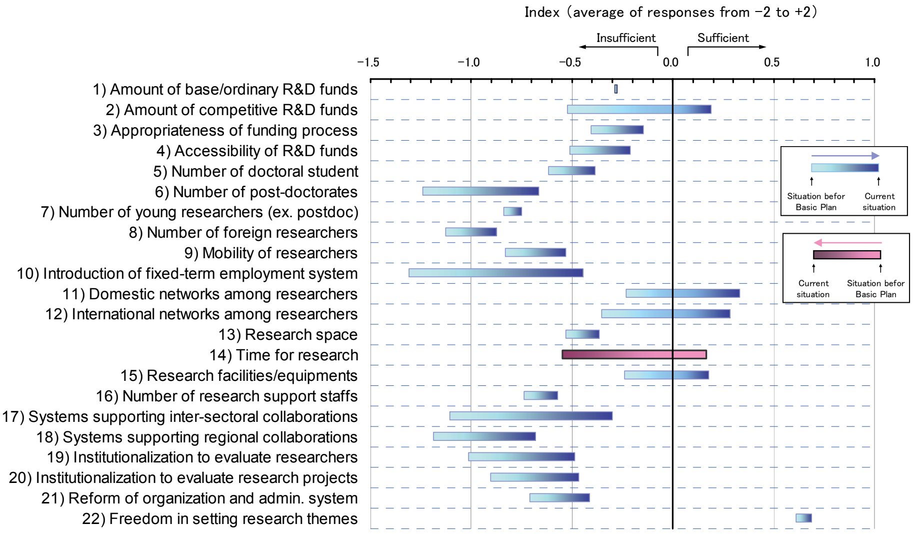
III. Opinions of researchers

Top-researchers’ opinions on change of research environment since *S&T Basic Plans*



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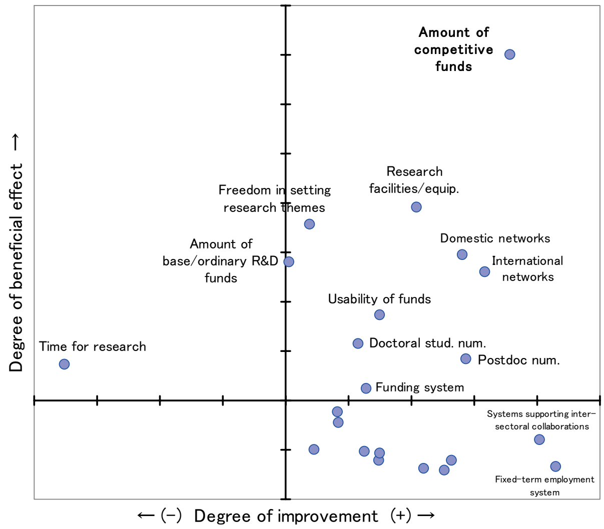
III. Opinions of researchers

Evaluation of policies through top-researchers' opinions



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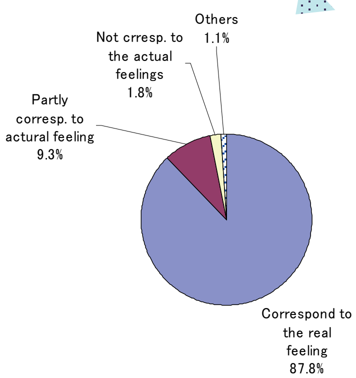
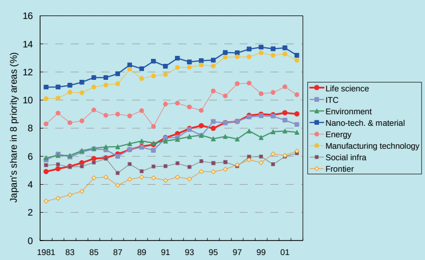
III. Opinions of researchers

Interpretation of quantitative data by top-researchers



Part of figures which indicated to "top researchers"



15

III. Opinions of researchers

Suggestion of top-researchers' opinions

- Positive opinions
  - General improvement of research environments and its positive effect on top-researchers' activities
    - Suggests S&T policies were effective
    - More improvement is still needed by top-researchers
- Point out some problems
  - Human resource development
  - Appropriateness of resource allocation
  - Anxiety for long-term and fundamental research

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Concluding remarks:

- Partial success of Basic Plans
    - Improvement of research environment
    - High performance of semi-governmental institutes
- Quality of research
    - Big issue for Japan's S&T policy
  - Improving capability of knowledge production in universities
    - ***Raising standard as a whole*** vs. ***Forming selected excellent univ ?***
- Scientific research for innovation capability
    - As a long-term fundamentals for innovation
    - As a key factor of innovation system of Japan

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Dr. Mu Presentation

Dr. Hill: Our second speaker in this part of the session is Dr. Mu Rongping from China. He is a very visible participant in meetings and discussions about science policy and evaluation internationally as well as in China. He is Director-General and a professor in the Institute of Policy and Management of the Chinese Academy of Sciences. His business card shows that he is the director or president of a number of other related organizations in this field. Let us welcome Dr. Mu.

Dr. Mu Rongping, Director-General, Institute of Policy and Management (IPM), Chinese Academy of Sciences (CAS): Thank you, Professor Hill. It is really great that we five research institutions joined to hold such a session in the United States, not in Asia.

[Slide 2] The topic of my presentation is the changing national innovation strategy in China: policy analysis and evaluation. My presentation consists of five parts, but because of limited time I have to focus on the third and fourth parts.

[Slide 3] China has made great achievements in system reform and economic development, since it implemented the policy of the reform and opening in 1978. During the past two decades China has taken lots of measures, such as establishing the Special Economic Zones (SEZ), the Economic Technology Development Zones, the Hi-tech Industry Development Parks, the opening of coastal cities, the development of western China, the development of the northeast of China, the development of central China，and the reforms concerning the pricing system, public finance, taxation, banking and trade, which have great impact on reforming the system of socialist market economy.

[Slide 4] The success of policies for reform and opening has resulted in over 20 years of high-speed economic growth in China and has made China the fourth largest economy in the world. However the economic growth of China mainly relies on increasing investment instead of innovation, although China has made great progress in building up indigenous capacity for science and technology and innovation. Therefore it is necessary to review the system reform for science and technology so as to identify the key issues for changing strategy and policy of innovation.

[Slide 5] The second part is the science and technology system reform since 1985. Chinese economic reform has experienced a process from reforming the micro-operation mechanism to reforming the allocation system for resources, and finally to setting up a socialist market economy system. The reform of the science and technology system has experienced a process from extending the decision-making power of R&D institutions to reforming the R&D funding systems gradually to introduce the market mechanism into science and technology systems, and making some progress in science and technology legislations, and finally into setting up new science and technology systems which are in favor of science and technology development and the integration of science and technology and the economy.

[Slide 6] The reforms of science and technology systems in China can be divided into three periods. The first is to introduce competitive mechanisms into science and technology systems. The second is to integrate the reform of science and technology systems with the reform of economic systems. The third is to construct national innovation systems.

[Slide 7] For example in the first stage, the science and technology policies mainly focused on the reform of funding systems, the technology market, the personnel system with a view to promoting the integration of organizations concerning research, education, design and production in this period, and required the researchers to compete for the funds from national programs.

[Slide 8] In the second stage the most important event occurred in 1992 when China decided to establish the socialist market economy instead of the so-called planned economy, and issued the law for progress in science and technology in 1993, which was very important. It stated that the development of science and technology should serve national economic development, while national economic development should rely on the development of science and technology.

[Slide 9] In the third stage the most important milestone was the Chinese government launching the pilot project of the knowledge innovation programs in the Chinese Academies of Sciences, and also at the same time they dismissed 10 ministries and transformed 242 research institutions into 134 research institutes affiliated to the above ministries. They also issued lots of effective policies, especially some policies for promoting and encouraging the development of software and IC industry, which had a very positive impact on the industry development.

[Slide 10] Generally speaking, China has issued more than 2,000 pieces of innovation policy, including science and technology policy, with a view to strengthening the indigenous capacity for science and technology innovations since 1978. In fact especially since 1998 there have been lots of policies—more policies than before.

[Slide 11] The third part: the issues on innovation capacity in China. First, the investment in R&D. The expenditure for R&D in China increased very fast, and it is expected that R&D expenditure reached 300 billion RMB last year, which accounts for about 1.5% of the GDP.

[Slide 12] The ratio of R&D expenditure of GDP increased from 0.6% in 1995 to about 1.5% in 2006, there is a big change. This is the quantity change. [Slide 13] Enterprise has played an increasingly important role in R&D expenditure since 1998, especially the large-sized companies with technology development centers (TDCs) authorized by the State Commission for Development and Reform. All together now there are about 460 TDCs. [Slide 14] The ratio of R&D expenditure to sales in these enterprises increased obviously during the past five years.

[Slide 15] The number of full time equivalent (FTE) R&D personnel and S&E has also increased since 1998. [Slide 16] China has become one of the largest countries in terms of human resources of science and technology, and [Slide 17] is trying to become one of the largest countries in terms of science and technology papers taken by SCI, EI, ISTP. But as our Japanese colleague showed us, if you see the citations, which does reflect the quality of papers, China is still far behind the United States and other countries in terms of citations.

[Slide 18] As to the patents, the application for invention patents received has increased from 10,018 pieces in 1995 to 93,485 pieces in 2005. It has also increased dramatically. The ratio of three kinds of patent application received has also increased from 14.5% to 24.4%. That means the invention patent ratio tends to account for more shares.

[Slide 19] But when we look at these patents in detail we find that the advantage of foreigners—the invention patents granted to foreigners in China, mainly in high technology fields, while the invention patents granted to Chinese in China mainly in the fields of drink, food, and Chinese traditional medicine. In the future the competition in the high technology industry mainly focuses on the competition of patent generation, which determined the international competitiveness of selected industries.

[Slide 20] The variety of technology contractual deals in the domestic technical market increased also very quickly since 1998. [Slide 21] But the productivity of S&E in China is still lower than that in developed countries. For example the number of scientific papers taken by SCI per 10,000 S&E is much lower than that in developed countries such as England, Switzerland, and the United States, and so on. [Slide 22] Similarly, the number of domestic applications for invention patents per 10,000 S&E is also very small.

[Slide 23] As you know, usually we emphasize that innovation is an important driving force for economic development. S&E is the key to innovation. However S&E per GDP in China is about 4.5 times of that in the United States and about 3.1 times of that in Japan. That means the S&E do not play so well as that in the developed countries, or the allocation of HRST is not rational in terms of economic developments.

[Slide 24] In short we can identify the following issues. The R&D investment and the output have increased dramatically in the past 10 years. China has become one of the large countries in terms of scientific papers, patents, human resources of science and technology. However, there is still a big gap between China and many developed countries if we pay more attention to the quality of output, such as the quantity of paper citations, the ratio of commercialized patents to the total. The effectiveness of R&D investment is still lower than many developed countries, if we consider the quality of output. In particular, the innovation capacity of enterprises, especially in high technology sectors, is still a critical issue if we count the average number of patents per enterprise in China or the ratio of imported technology to technologies bought domestically. Lots of Chinese enterprises have no patents now.

[Slide 25] Generally speaking following issues are critical to the changing innovation strategy and policies. First, the investment in innovation: although it has increased very fast it is still insufficient. The second issue is allocation of innovation resources; it is unbalanced. When we look at the quantity of scientific papers and the share of innovation patents, China accounts for about 6% of the scientific papers in the world; and as to the invention patents, China accounts for only about 4%. Third, the number of R&D organizations: although we have always emphasized the importance of innovation, the research organizations in large and medium sized enterprises continually decrease.

Fourth, the R&D innovation personnel are insufficient, and in-qualified. As to the mobility, the flow from university and institutions to enterprises: there are barriers to this flow. Fifth, the linkage among science and technology, economy, and education is very weak. During the past five years, because of the expansion of the education systems, lots of graduates cannot find the right job. At the same time the enterprises, even the universities themselves, cannot find the right staff from the graduates. The sixth is IPR and standardization strategy: there is a very weak linkage. Seventh, there is a less effective incentive mechanism for firms' innovations. That means the motivation for enterprises to innovate is not so strong. There are many other possibilities for them to profit, not profit from innovation. Eighth, the evaluation system is less effective so far. The last is the mechanism for cooperation among industry and university and research institutions: there are lots of barriers. For example, there are some preferential policies to encourage research institutions and universities to run business so as to "commercialize" their research results. I think these policies to some extent are barriers for technology transfer from research institutions and universities to enterprises. The research institutions and universities want to commercialize their profitable technology by themselves so as to make money with support of preferential policies, and to transfer the less or not profitable technology to enterprises. Therefore, the preferential policies to a great extent make the research institutions, universities to compete instead of cooperate with enterprises in the market.

[Slide 26] The last part, the changing innovation strategy and policy. The forum on Strategy Study on National Medium- and Long- Term Plan for Science and Technology Development (NMLPSTD) was held on 24 June 2003, which was also a dialogue between scientists and economists. One of the key issues was the priority of so-called innovation and technology import. There was no solution at that forum. From then on, China began to conduct the strategy study. Last year the government issued the guideline for NMLPSTD, and supportive policies for implementing this plan. As Prof. Yang Qiquan has mentioned, China has set up the goals for 2020, namely to become an innovation-driven country.

[Slide 27] The innovation strategy in China has changed from keeping the balance of allocation of innovation resources in all subsystems of the national innovation systems to strongly promoting capacity building for innovation in enterprises. There is a political term, so-called *zhì zhǔ chuàng xīn* that sometimes translates into "indigenous" and sometimes translates to "independent." Prof. Yang has mentioned and I do not want to explain here, I just want to emphasize that indigenous innovation imply to grasp the technological learning opportunities for catch-up countries, to keep the balance of national strategic demands and the frontiers of science and technology, and to build up innovation capacity in enterprises at different levels, namely the original innovation, integrated innovation, and innovation based on imported technology, these three levels.

[Slide 28] In order to solve the problems and issues mentioned above, we have made some suggestions in the process of making supportive policies, some of which have issued in the supportive policies for implementing this plan, while the other suggestions are still in the further discussion in details. The first part of these suggestions is science and technology input, namely to increase the science and technology expenditure dramatically and maintain a growth rate faster than governmental regular revenues; to adjust the structure of science and technology expenditure and the structure of national science and technology programs, so as to stimulate enterprise investment in innovations; to set up a new mechanism for managing public science and technology expenditure; to innovate a new management mechanism for public science and technology expenditure.

[Slide 29-30] The second part is taxation incentive policies, namely to encourage enterprises to increase investment in technology development, about 50% of which comes from tax deduction; to provide tax deduction for imported facilities and instruments, and policies for speeding up the depreciation of facilities and instruments, so as to upgrade enterprise experimental facilities and instruments; to provide the tax incentives for equipment, instruments, and materials imported by the Enterprise Technology Development Center of enterprises and Engineering Research Center, and for the National Science and Technology Program so as to promote capacity building for innovation in enterprises; to support the development of transformed research institutes, the development of venture capitals, and the science and technology service institutions, by providing tax deduction.

[Slide 31] The third part is government purchase policies, namely to promote indigenous innovation by providing various measures relating to government purchase. The fourth part is finance support policies, concerning the seed fund, VC, bank, stock market. I have no time to give details. The fifth is policies for innovation based on imported technology, namely to strengthen the management of technology imports and assimilations, to make special technology policy and to list technologies to be encouraged or limited so as to strengthen the capacity building for innovations.

[Slide 32] The sixth is related to the IPR protection and generations, namely to support enterprises to generate and protect IPRs; to engage in standard-making procedures, both at a national and international level; to speed up the check-up cycle of patent application; and to improve the system for IPR protection. The last part is to train qualified human resources of science and technology, and promote the flow to firms.

[Slide 33] Finally, the conclusion remarks. The goal for China to become an innovation-driven country is very ambitious which depends on many factors. Firstly, it depends on the efficiency, effectiveness, and the efficacy of the technology learning process. Secondly, it depends on the effectiveness of the mechanism for implementing and adjusting supportive policies. Thirdly, it depends on the effectiveness of setting up the innovation-friendly culture. Fourthly, it depends on the effectiveness of talent training. And finally, it depends on the efficacy of international cooperation. Thank you all.

Dr. Hill: Thank you very much.

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Changing National Innovation Strategy in China: Policy Analyses and Evaluation

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Content

I. Introduction

•China has mad great achievement in system reform and economic development since it implemented the policy of the reform and opening in 1978.

•During the past two decades, China has taken lots of measures such as establishing the Special Economic Zones (SEZ), the Economic Technology Development Zones, the Hi-tech Industry Development Parks, the Openness of Coastal Cities, the Development of Western China, the Development of Northern East of China, the Development of Central China, and reforms concerning the pricing system, public finance, taxation, banking and trade, which have great impact on reforming the system of socialist market economy.

I. Introduction

•The successful policies for reform and opening has resulted in over 20 years of high-speed economic growth in China and made China the fourth largest economies in the world. However, the economic growth of China mainly relies on increasing investment instead of innovation although China has made great progress in building up indigenous capacity for S&T and Innovation.

•Therefore, it is necessary to review the system reform for science and technologies so as to identify the key issues for changing strategy and policy of innovation.

II. S&T System Reform since 1985

- China economic reform has experienced a process from reforming micro operational mechanism to reforming allocation system for resources, finally to setting up socialist market economy system.
- The Reform of Science & Technology System has experienced the process from extending decision-making power of R&D institutes to reforming R&D funding system, gradually to introducing the market mechanism into S&T system and making some progresses in S&T legislation, finally to setting up new S&T System, which is in favor of the S&T Development, of the integration of S&T and economy.

II. S&T System Reform since 1985

The reform of S & T system in China could be divided into three periods, namely:

(1) to introduce competitive mechanism into S&T system (1985-1992).

(2) to integrate the reform of S&T system with the reform of economic system (1992-1998).

(3) to construct national innovation system (1998-2005).

II. S&T System Reform since 1985

(1) to introduce competitive mechanism into the system of science and technology (1985-1992).

•The S&T policies mainly focused on the reform of funding system, technology market, personnel system with a view to promoting the integration of organizations concerning research, education, design and production in this period.

•Generally speaking, China had taken issued several important laws and regulations as well as a series of national programs such as program for hi-tech development (so called 863 program) so as introduce competitive mechanism into the allocation of innovation resources during the period.

II. S&T System Reform since 1985

(2) to integrate the reform of S&T system with the reform of economic system (1992-1998).

•In 1992, China decided to establish the socialist market economy which had profound impacts on system reform of S&T.

•China took great effort in making related laws and regulation. The law for progress in S&T was issued in 1993, which states that development of S&T should serve national economic development, while national economic development should rely on development of S&T.

•China launched the National Basic Research Program in March 1997 with a view to encouraging top scientists to target both the national strategic demands and the S&T frontiers.

II. S&T System Reform since 1985

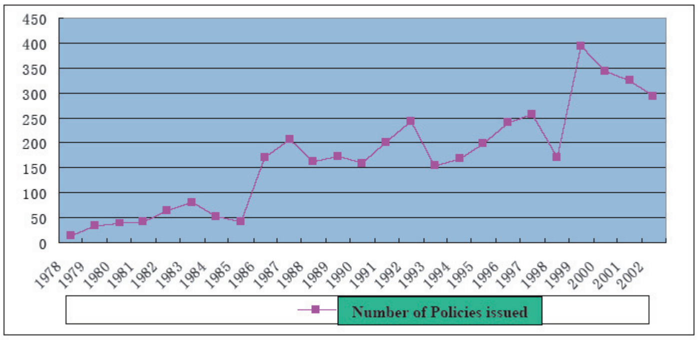
(3) to construct national innovation system (1998-2005).

•In 1998, China decided to build up national innovation system so as to face challenges resulted from the emerging knowledge economy. Firstly, the State Council launched the Pilot project of Knowledge Innovation Program (KIP) in the CAS.

•secondly, it decided to dismiss ten ministries and to transform 242 R&D institutions (later 134 institutes) affiliated to above ministries.

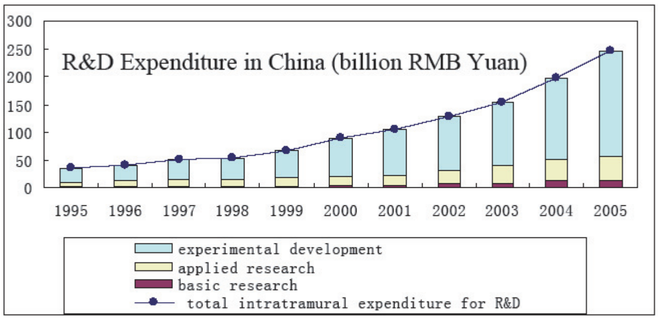
•China has issued some very effective policies, such as the " Decision on Strengthening Technology Innovation, Developing and Industrializing the Hi-tech", "Some Policies for Encouraging the Development of Software and IC Industry".

II. S&T System Reform since 1985



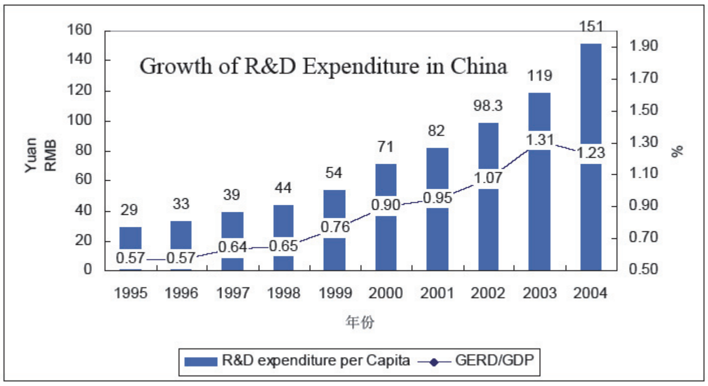
Generally speaking, China has issued more than 2000 pieces of innovation policies (including S&T policy) with a view to strengthening indigenous capacity for S&T and innovation since 1978

III. Issues on Innovation Capacity in China



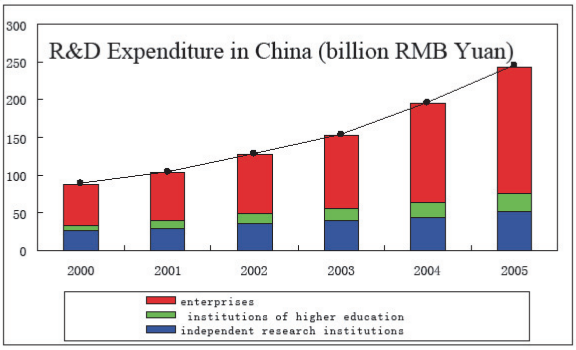
The expenditure for R&D in China increased very fast, from 34.869 billion RMB yuan in 1995 to 244.997 billion RMB yuan in 2005. It is expected that R&D expenditure reached to 300 billions RMB yuan.

III. Issues on Innovation Capacity in China



The ratio of the R&D expenditure to GDP in China increased from 0.6% in 1995 to 1.34% in 2005, and to about 1.5% in 2006.

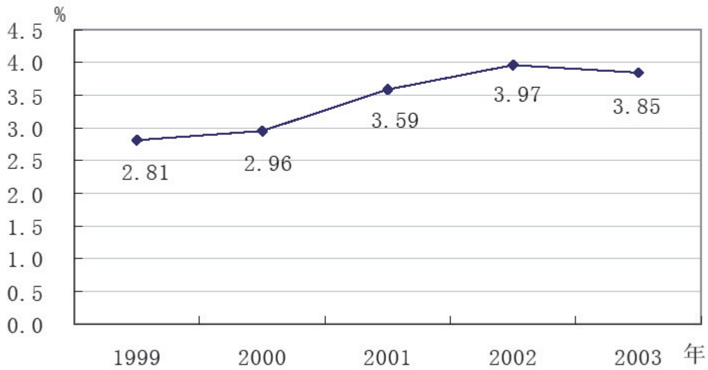
III. Issues on Innovation Capacity in China



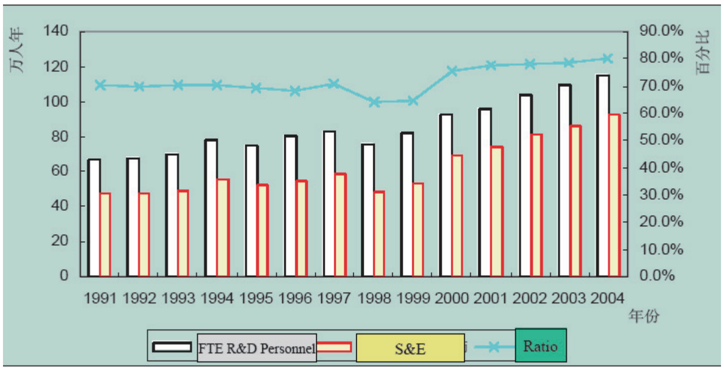
Enterprises play increasingly important role in R&D expenditure since 1998.

III. Issues on Innovation Capacity in China

The ratio of R&D expenditure to sales in firms with TDCs

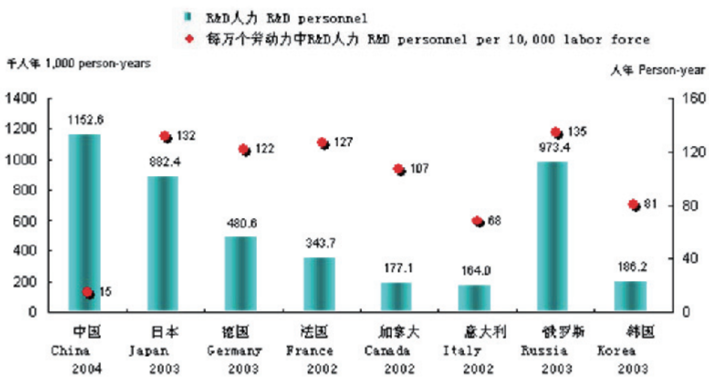


III. Issues on Innovation Capacity in China



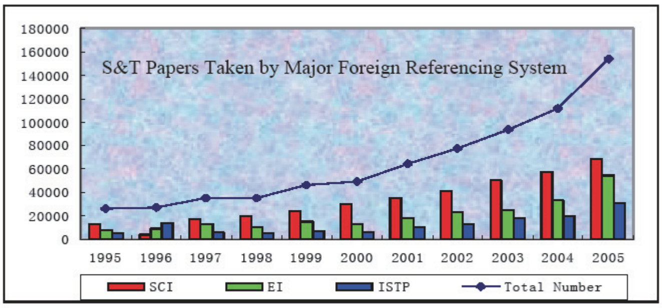
The number of FTE R&D personnel and S&E has increased since 1998.

III. Issues on Innovation Capacity in China



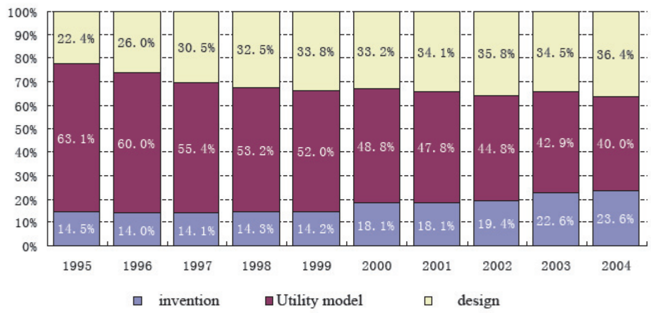
China becomes one of largest countries in HRST.

III. Issues on Innovation Capacity in China



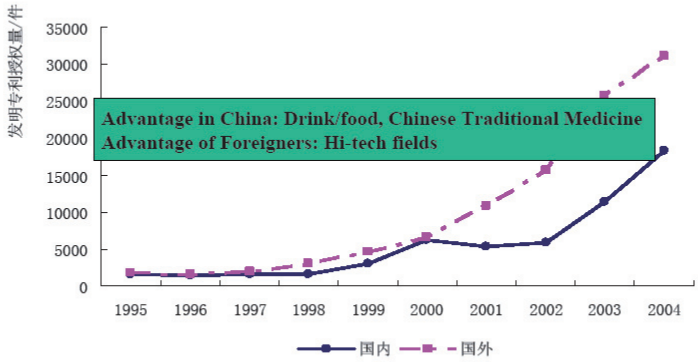
China becomes one of largest countries in S&T papers taken by major foreign referencing system .

III. Issues on Innovation Capacity in China



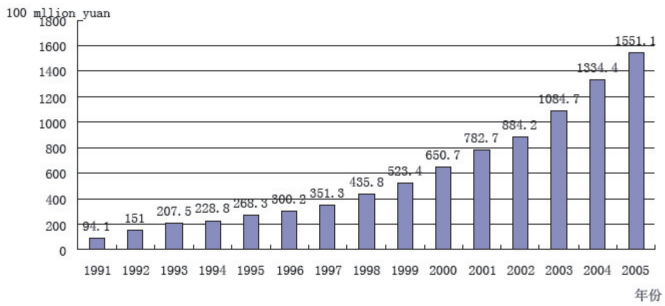
The applications for invention patent received has increased from 10018 pieces in 1995 to 93485 pieces in 2005, the ratio to three kinds of patent applications received also has increased from 14.5% to 24.4%.

III. Issues on Innov-Capacity in China



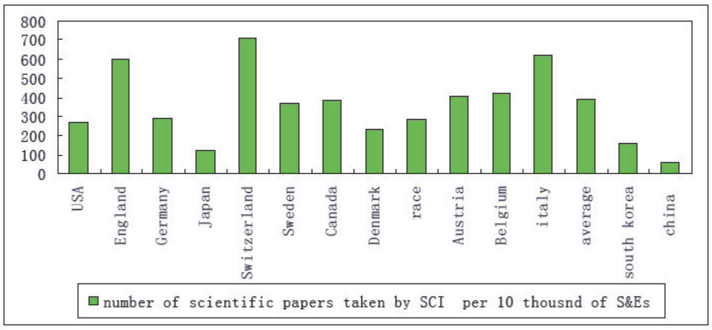
The number of invention patents granted to foreigners is still much more than to Chinese.

III. Issues on Innovation Capacity in China



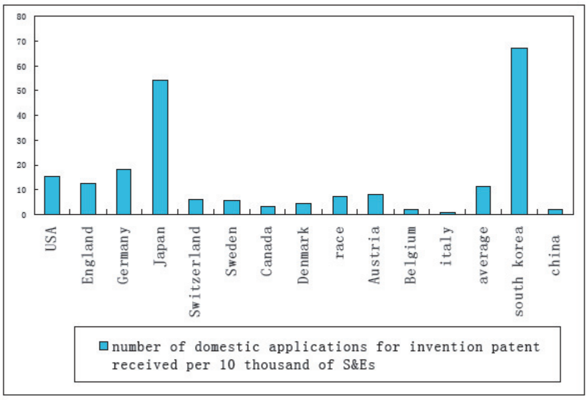
The value of Technology Contractual Deals in Domestic Technical Market increased also very fast since 1998.

III. Issues on Innovation Capacity in China



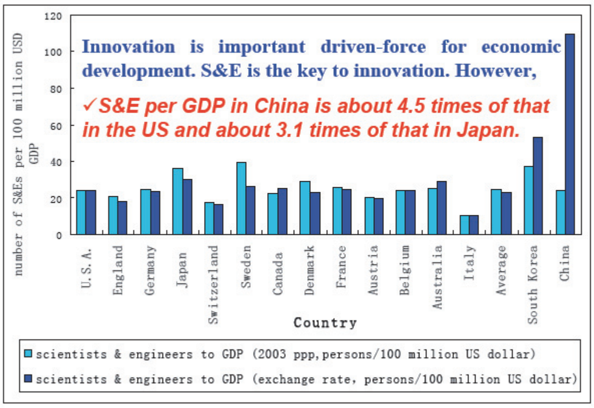
But, the productivity of S&E in China is still lower than that in developed countries. For example, the number of scientific papers taken by SCI per 10,000 S&Es is much lower than that in developed countries.

III. Issues on Innovation Capacity in China



Similarly, the number of domestic applications for invention patent per 10,000 S&Es is also very small.

III. Issues on Innovation Capacity in China



Relation between the number of S&E and GDP

III. Issues on Innovation Capacity in China

1. R&D investment (Money, HRST) and the output (paper, patent) have increased dramatically. China has become one of largest countries in terms of scientific papers, patents, HRST.
2. However, there is still big gap between China and many developed countries if we pay more attention to the quality of outputs such as the quantity of paper-citations, the ratio of commercialized patents to the total.
3. The effectiveness of R&D investment is still lower than many developed countries Even if we consider the quantity of output.
4. In particular, the innovation capacity of enterprises (especially in hi-tech sectors) is still critical issue if we count the average number of patents per enterprise in China, or the ratio of imported technologies to technologies bought domestically.

Key Issues and Barriers Identified

Generally speaking, following issues are critical to the changing innovation strategy and policies.

1. Investment in innovation:– insufficient
2. Allocation of innovation resources: – un-balanced
3. The number of R&D organizations: – decreased
4. R&D/innovation personnel: – insufficient/qualified, mobility
5. The linkage among S&T, economy & education: Weak
6. IPR and standardization strategies– lack of effective linkage
7. Incentive mechanism for firm's innovation: –less effective
8. Evaluation system for : –less effective
9. Mechanism for cooperation Industry and Uni/Inst. barriers

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IV. Changing Innovation Strategy and Policy

•On 24 June 2003: Dialogue between Scientists & Economist
•Strategic Study for M-L term plan of S&T development
•The M-L Term Plan for S&T Development (2006)
•Supportive Policy for Implementing the Plan (2006)
•The 11th five-year Plan (2006)

•Goals for 2020 is to become Innovation-driven Country.
•The innovation strategy in China has changed from keeping balance of allocation of innovation resource in all sub-systems of NIS to strongly promoting the capacity-building for innovation in enterprises.

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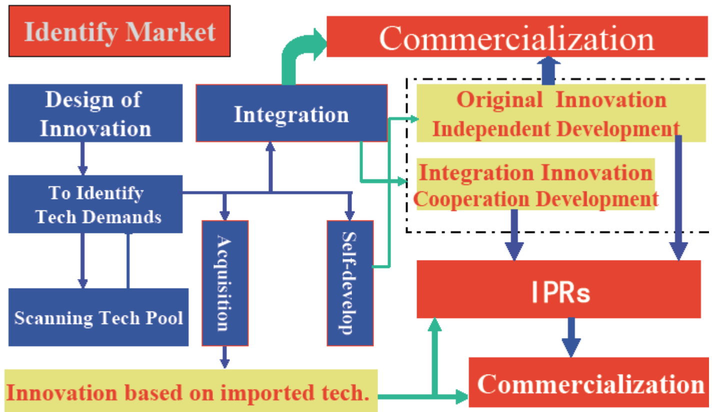


Indigenous Innovation emphasizes to grasp the learning opportunity, to keep the balance of national strategic demands and the frontiers, and to build up innovation capacity in enterprises in different level.

IV. Changing Innovation Strategy and Policy

1. S&T Input

•To increase S&T expenditure dramatically and maintain a growth rate faster than governmental regular revenues.

•To adjust the structure of S&T expenditure and the structure of national S&T programs so as to stimulate enterprises' investment in innovation.

•To set up new mechanism for managing public S&T expenditure.

•To innovate a new management mechanism for public S&T expenditure. (Evaluation)

IV. Changing Innovation Strategy and Policy

2. Tax Incentives

•To encourage enterprise to increase investment in technology development, 50% of which comes from tax deduction.

•To provide tax deduction policy for imported facilities & instruments, and policies for speeding up the depreciation of the facilities and instruments so as to upgrade enterprises' experimental facilities & instruments.

IV. Changing Innovation Strategy and Policy

2. Tax Incentives

•To provide tax incentives for equipments & instruments & materials imported by ETDC & ERC or for National S&T program so as to promote capacity building for innovation in enterprise.

•To support the development of transformed research institutes, the development of venture capitals, and S&T service institutions by providing tax deduction.

IV. Changing Innovation Strategy and Policy

3. Government Purchase

•To promote the indigenous innovation by providing various measures related government purchase.

4. Finance Support (seed fund, VC, bank, stock market)

5. Innovation based on imported/assimilated technology

•To strengthen the management of technology import and assimilation.

•To make special technology policy and to list technologies to be encouraged/limited so as to strengthen capacity-building for innovation.

IV. Changing Innovation Strategy and Policy

6. To create and protect the IPRs.

•To support enterprise to generate & protect IPRs, to engage in standard-making procedure both at national and international level.

•.To speed up the checkup cycle of patent application, and improve the system for IPR protection.

7. To train qualified HRST & promote them flow to firm

•To train talents in different level from top scientist to skilled workers. To encourage the flow of talents from Universities to enterprises. To set up S&T credit system.

V. Conclusion Remarks

- The goal for China to become innovation-driven country is very ambitious, which depends on many factors.
- Firstly, it depends on the efficiency, effectiveness, efficacy of technology learning process.
- Secondly, it depends on the effectiveness of mechanism for implementing/adjusting supportive policies.
- Thirdly, it depends on the effectiveness of setting up the innovation-friendly culture.
- Fourthly, it depends on the effectiveness of talents training.
- Fifthly, it depends on the effectiveness, efficacy of international cooperation.

Thank you for your attentions

谢谢!

Dr. Park Presentation

Dr. Hill: Our final speaker of the day before we have another opportunity for some questions and answers is Dr. Jiyoung Park from Korea. She is the Director of the R&D Feasibility Analysis Team at the Korea Institute of Science and Technology Evaluation and Planning. The title of her talk is "Challenges and Responses for Korea's National Innovation System." Dr. Park.

Dr. Jiyoung Park, Director of R&D Feasibility Analysis Team, Korea Institute of Science and Technology Evaluation and Planning (KISTEP): Good afternoon. I would like to talk about the challenges and the responses for Korea's national innovation system.

[Slide 2] These are the contents I am going to go through today. Korea has achieved remarkably rapid industrial and technological catch-up in just a few decades and NIS has evolved over the time but in the early 2000s, we encountered a serious limitation of our system and we had to build a new NIS system. So today I am going to tell you about the brief history of science and technology system in Korea and recent reforms.

[Slide 4] Korea has experienced fast economic growth for a few decades. Korea was the 11th in its GDP in the world in 2005 and its population has been doubled for a decade and the GDP growth rate remained very high over a few decades. The high economic growth was due to the "Factor Input (Labor and Capital) led Growth Model." It is due to cheap labor, export-orientated industrialization strategy and transition from labor-intensive to capital-intensive industry, and very strong initiative of the government.

[Slide 5] Also, there have been changes of science and technology environment in Korea. From the viewpoint of policy trend, it has been transformed from industry orientated policy to technology orientated policy. The science and technology policy direction has changed from building R&D infrastructure through promoting R&D to enhancing technology innovation. The focusing industry was also changed. In 1960s it was primary goods and in 2000 it was electronic and transport products.

[Slide 6] For the government side, in 1967 the Ministry of Science and Technology was established and Korea became the first developing country which had a ministerial level government agency for science and technology development. We built Daedeok Science

Town in 1974 and the town has 834 R&D institutes in its boundaries. In 1982 we initiated the national R&D programs and recently in 2004, we elevated the Minister of Science and Technology to the Deputy Prime Minister to coordinate inter-ministerial coordination of the national R&D programs.

[Slide 7] For the private sector the number of private sectors in the R&D centers increased from 100 centers in 1982 to 11,810 centers in 2005. It was 120 times for 23 years. Private sector's R&D investment increased by seven times since 1982 and the contribution of the private sector to national R&D investment also has been increased. Major companies ranked at high position of R&D investment.

[Slide 9-10] It is the point of the science and technology development and achievement in Korea for the quantitative growth to increase in R&D input. In 1963, it was only US$4 million and in 2005 it was US$23,580 million and it ranked 7th in the world. R&D expenditure to GDP was about 3% in 2005 and it is ranked 8th in the world. The number of researchers has tremendously increased and in 2005 it ranked 6th in the world. For the science and technological competitiveness Korea has ranked highly in recent years. [Slide 11] Also, we achieved a lot of things in biotechnology and nanotechnology or information technology.

[Slide 13] Apart from those achievements, now I will talk about the challenges we have experienced recently. First, we encountered the serious limitation of labor and capital led growth model. The GDP growth rate is decreasing and the rate of increase in population is also very low and index of aging is very high.

[Slide 14] Therefore we realized we need innovation-led growth model. 21st century is a knowledge based economy and the era of fierce global competition based on science and technology strength. Technology innovation is a new growth engine to leap over the growth limit through factor input. So in 1970s, the labor and capital was the leading factor. In late 1990s, we found that technological innovation should be the leading factor for the economic growth and it means that we called for a swift transition to an innovation led growth model.

[Slide 15] The first problem and solution was to increase the efficiency of R&D investment. The growth rate of economic contribution index in Korea against 1% of increase of R&D input index is 0.37% and it is far behind if we compare with the developed countries of 0.52%. Even worse, we experienced the decrease in contribution of R&D to economic growth. From 1990 to 1998 it was 27.6% and currently it is down to 16.9%.

[Slide 16] The second one is we had to build portfolio of national R&D towards innovation-led model. For the research stage, in 2005 we are focused on developing research with about half of our budget and our future target is to increase the basic research. For research entity, the major research entity currently is the research institute and the future target is increasing university research. We are now focusing on information technology, about 20%, but our future target is mitigation of imbalanced investment on information technology. For the region, the national capital region we perform about half of the research and the future target is strengthening the local R&D.

[Slide 17] The third solution is from quantity to quality. In general technology level in Korea remains at the level of 60-80% of advanced countries. It means we have some problems in core components and parts, system software technology. Although the number of SCI papers has considerably increased, the citation level is still low. It is the problem that the all of the three countries have been experiencing. We have deficit in technological balance of payments and continue due to the lack of fundamental technology.

[Slide 18] The Fourth one is human resource development. We have a mismatch between demand and supply and we are expecting a shortage of high quality manpower through 2015. We are expecting about 4,500 PhD shortages. The second one is brain-drain index. Korea’s brain-drain problem is very high and if you see the index, United States’ brain-drain index is about 8.96 and we are only half of that so Korea has 4.91. We have to foster creative core manpower and for the selection and concentration, we have to foster R&D orientated university. We also have to shift from the brain-drain to brain-circulation stage.

[Slide 19] Last but not least, we are having problems on the globalization so we have to have some policy to activate globalization of science and technology. As you can see in this diagram, in the diversity of innovation, innovation institution, education and training, all other things, we are very highly ranked but for science and technology globalization, Korea’s overall capacity for globalization is the lowest among the OECD countries.

[Slide 21] For those problems, we needed to reform our national innovation systems. What were the changes and/or the problems? IT became a strong base of the industrial structure and society and we had a rapid growth of our R&D expenditure. We have lots of R&D sponsoring ministries now and the number of researchers has been tremendously increased. A weak linkage among industry, academia and research institutes has been the problem. Also in the human resources we have mismatch between demand and supply. So we need emphasis on innovation orientated S&T activity and we need more effective government reaction and efficient resource allocations.

[Slide 22] So, directions. First, efficient allocation and utilization of our R&D resources are needed. The second, we had to strengthen the innovation capabilities. Those two are intended from imitation mode to innovation mode. Third one, collaboration among industry, academia and government supported research institutes. Fourth one is openness. These two are intended from closed mode to open and networked mode.

[Slide 23] This was the re-structuring science and technology administration system in 2004. We have Deputy Prime Minister and he is in the Ministry of Science and Technology. Under the Deputy Prime Minister we have Office of Science and Technology Innovation. [Slide 24] Before the reform we have all the governments who are planning their programs and executing their programs and also evaluating their programs. [Slide 25] After the reform it has been more centralized, so the Office of Science and Technology Information (OSTI) conducts all the coordination, planning and evaluation of science and technology related policies and R&D programs. Also, it does the R&D budget allocation and all other ministries plan their policy and execution.

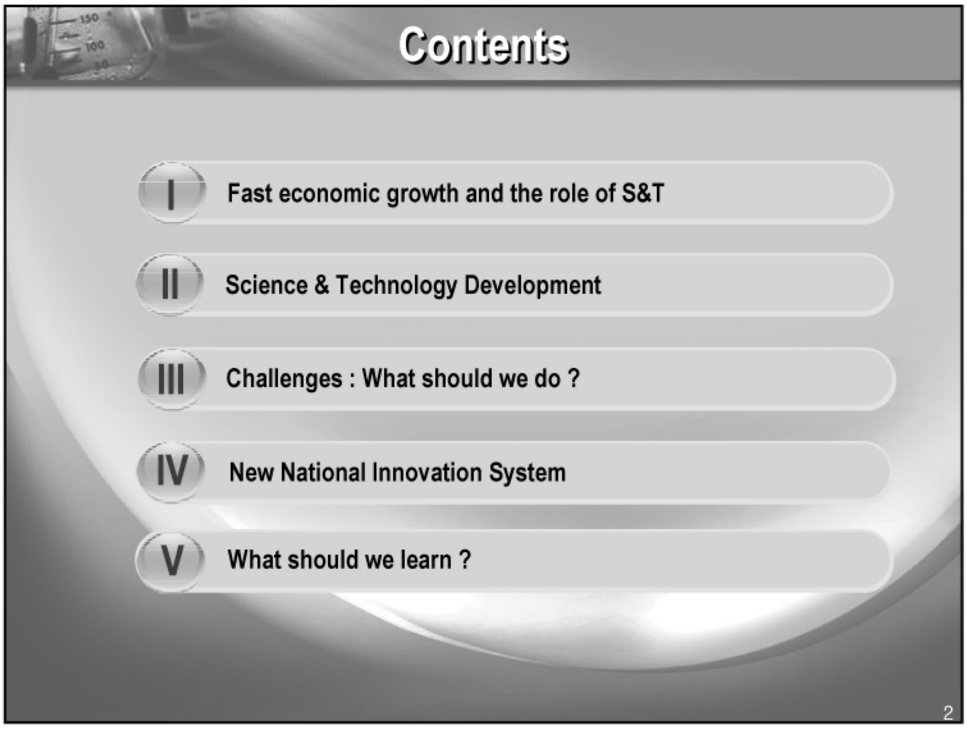
[Slide 26] Korea Institute of Science and Technology Evaluation and Planning (KISTEP), which is my institution, supports OSTI in all the coordination and evaluation work. [Slide 27] We also established the performance based evaluation system which is KNES. For the KNES Office of Science and Technology Innovation set up the plans and formed evaluation committees to do all the evaluation work. [Slide 28] To solve the problem I stated earlier, we had to select and concentrate on the national R&D strategies. We selected 6 technologies, CT, ST, ET, NT, BT, IT and the concentration was over 56% in 2005.

[Slide 29] Also we had to effectively use of human resources to overcome the mismatch between supply and demand of human resources in science and technology by promoting demand orientated education. We built systematic links through the career development process and we promoted the participation of women in education and labor market participation in science and technology fields. We fostered research universities, and increased their international competitiveness in research education.

[Slide 30] For the global collaboration we promote the application of overseas S&T resources and we promote also the contribution to making world S&T development and solving global issues. We are promoting S&T partnership with developing countries.

[Slide 32] From those problems, challenges and responses, what should we learn? It is the concluding remarks and I think some over-laps with Dr. Chung’s conclusion. We found that science and technology should be economy-embodied. Selection and concentration should be performed in the small countries like Korea. And the ultimate key player of R&D should be the private sector. And for those things we need effective science and technology system. Also for the open innovation we need more globalization in our system. That is all my presentation. Thank you.

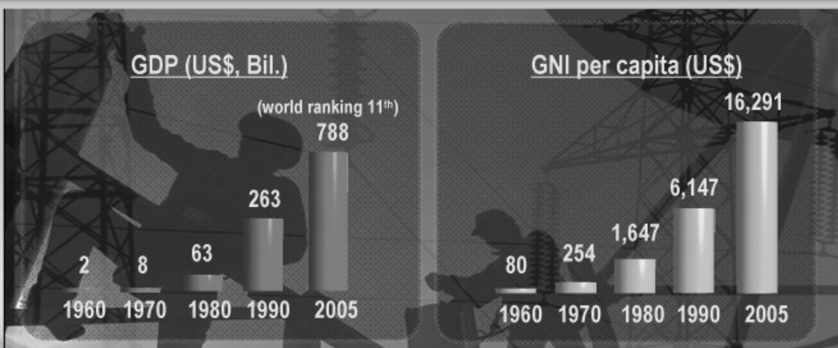

Challenges and Responses
for Korea's National Innovation System
OH
COOH
Korea Institute of S&T Evaluation and Planning


Contents
I Fast economic growth and the role of S&T
II Science & Technology Development
III Challenges : What should we do ?
IV New National Innovation System
V What should we learn ?
2

I. Fast economic growth and the role of science and technology

3

Fast Economic Growth of Korea



	1960	1970	1980	1990	2005
Population (1,000 people)	25,012	32,241	38,124	42,869	48,294
GDP Growth Rate (%)	1.2	8.8	-1.5	9.2	4.0

< Factor Input (labor & capital) – led Growth Model >

- Cheap labor
- Export-oriented industrialization strategy
- Transition from labor-intensive to capital-intensive industry
- Very strong initiative of the government

4

Changes of S&T Environments in Korea

	1960s	1970s	1980s	1990s	2000s
Policy trend	Industry-oriented policy			Technology-oriented policy	
S&T policy direction	Building R&D infrastructure ❙ Established GRIs (e.g. KIST) ❙ Established MOST in 1967 ❙ Built Daedeok Science Town in 1974		Promoting R&D ❙ Enforcing the national R&D programs ❙ Promoting the university-based researches (e.g. SRC, ERC)	Enhancing technology innovation ❙ Increasing efficiency of R&D investment (coordination of S&T-related policies) ❙ Planning Total Roadmap	
Change in focusing industry	Primary goods	Light industry goods	Light & heavy industry goods	Heavy industry goods & electronic products	Electronic & transport products

5

Brief History of S&T Policy by Sectors: Government

Government

- Established the Ministry of Science and Technology(1967)
  - Korea became the 1st developing country which had the ministerial level government agency for science and technology development
- Built Daedeok Science Town(1974)
  - 834 R&D institutes including 20 GRIs and 6 colleges are inhabiting(27.6km^2)
  - 14,387 researchers including 5,637 doctors are stationed
- Initiated the National R&D Programs(1982)
  - Domestic R&D capabilities in the areas of core and public welfare technologies with generic characteristics were enhanced
- Elevated the Minister of Science and Technology to Deputy Prime Minister(2004)
  - Inter-ministerial coordination of the national R&D programs was enabled (18 ministries are involved in R&D programs)

6

Brief History of S&T Policy by Sectors : Private Sector

- The number of private sector's R&D Centers highly increased
  - 100(1982) → 11,810(2005) ☞ 120 times, for 23 years!
- Private sector's R&D investment increased by 7 times since 1982
  - $2.7 billion(1982) → $18.6 billion(2005)
- The contribution of private sector to national R&D investment has increased
  - 50%(1982) → 77%(2005)
- Major companies ranked at high position of R&D investment(2004)
  - Samsung electronics: $2,242m (4th among the electronics companies)
  - Hyundai motors: $887m (15th among the motor companies)
  - LG electronics: $705m (7th among the electronics companies)
  - SK Telecom: $125m (9th among the telecommunication companies)

7

II. Science & Technology Development

8

S&T Development in Korea : Quantitative Growth

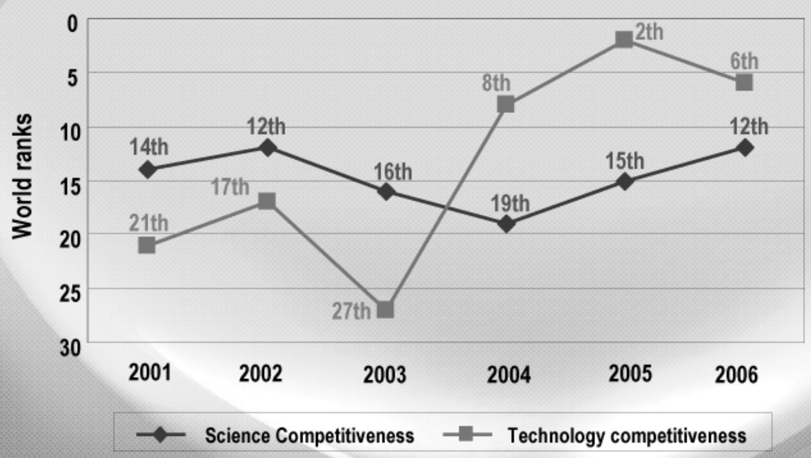
Increase in R&D Input

Year	1963	2005	World Ranks (2005)
R&D Expenditure	4 (Million USD)	23,580 (Million USD)	7th
R&D / GDP	0.25(%)	2.99(%)	8th
Researchers	5,628('70)	234,702	6th

Source : OECD

9

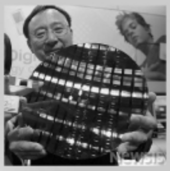
S&T Development in Korea : Quantitative Growth



Source : IMD reports

10

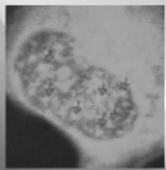
Achievements led by S&T



40㎚ 32Gb NAND Flash Memory (Samsung)

Structure of a junction between B-DNA & Z-DNA

DMB Service (Digital Multimedia Broadcasting)



Identifying "p18" cancer suppressor

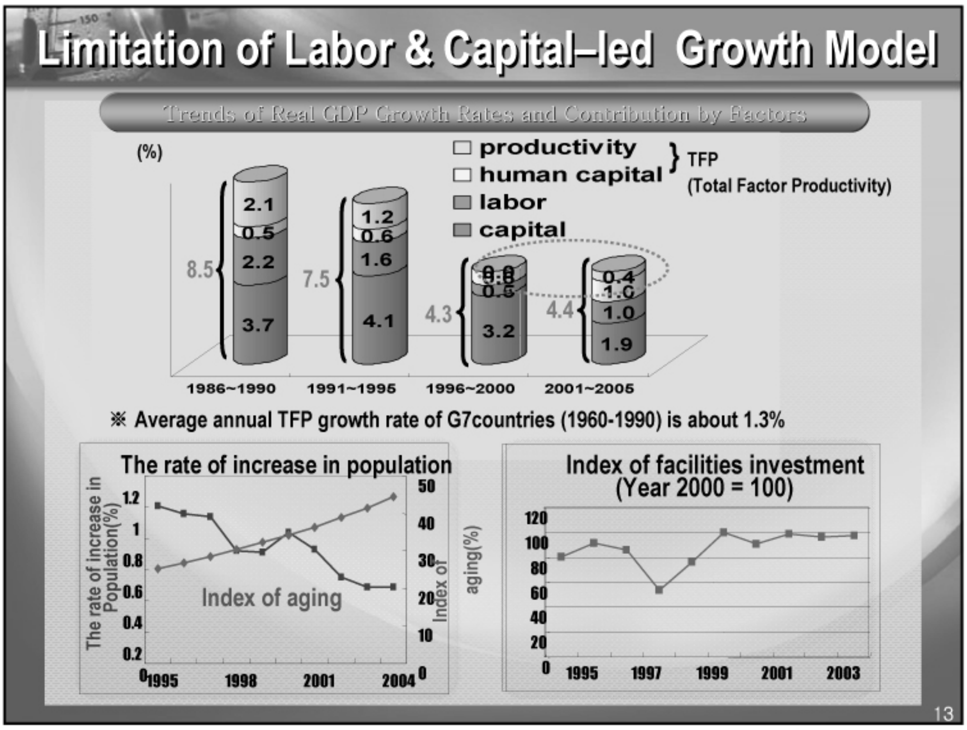
KOMPSAT-2 (Korea Multi-purpose Satellite: Arirang)

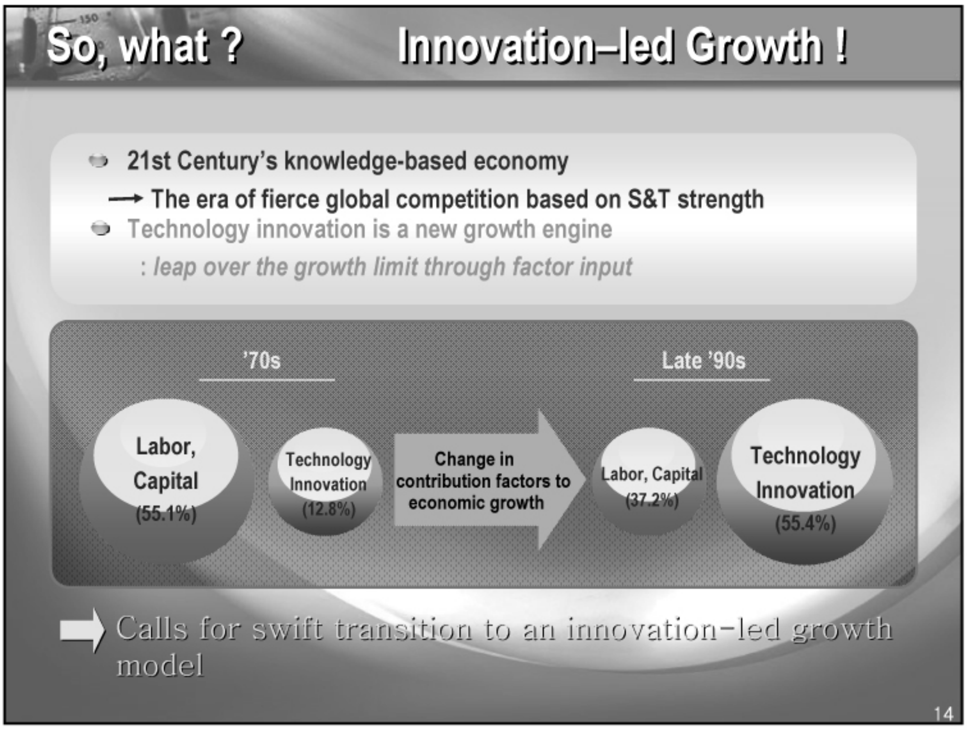
WiBro System (Wireless Broadcasting)

11

III. Challenges : What should we do ?

12


Limitation of Labor & Capital–led Growth Model
Trends of Real GDP Growth Rates and Contribution by Factors
(%)
productivity
human capital
labor
capital
TFP
(Total Factor Productivity)
8.5
2.1
0.5
2.2
3.7
7.5
1.2
0.6
1.6
4.1
4.3
3.2
4.4
0.4
1.0
1.0
1.9
1986~1990
1991~1995
1996~2000
2001~2005
※ Average annual TFP growth rate of G7countries (1960-1990) is about 1.3%
The rate of increase in population
The rate of increase in Population(%)
Index of aging
Index of aging(%)
1995
1998
2001
2004
Index of facilities investment
(Year 2000 = 100)
1995
1997
1999
2001
2003
13


So, what ? Innovation–led Growth !
21st Century's knowledge-based economy
The era of fierce global competition based on S&T strength
Technology innovation is a new growth engine
: leap over the growth limit through factor input
'70s
Late '90s
Labor, Capital (55.1%)
Technology Innovation (12.8%)
Change in contribution factors to economic growth
Labor, Capital (37.2%)
Technology Innovation (55.4%)
Calls for swift transition to an innovation–led growth model
14

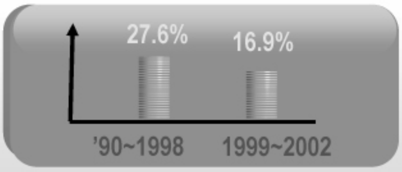
Challenges : What should we do ?

1 Increasing the Efficiency of R&D Investment

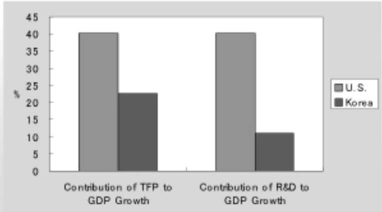
- Growth rate of economic contribution index against 1% increase of R&D input index

  ❑ Developed country : 0.52% , ❑ Korea 0.37% (KISTEP, 2005)

- Decrease in contribution of R&D to economic growth



(STEPI, 2003)



15

Challenges : What should we do ?

2 Portfolio of National R&D Towards Innovation - led Model

	Present Situation (2005,%)	Future targets
Research Stage	Basic (23.0), Applied (24.8), Developing (52.2)	Increase of basic research
Research entity	Research institute (49.4), University & college(23.5), Companies(15.6)	Increase of university research
6 Ts	IT (20.4), BT(15.2), NT(4.4), ET(9.5), ST(5.9)	Mitigation of imbalanced investment on IT
Region	National capital region(43.4), Daejeon(23.7), etc(32.9)	Strengthening of local R&D

16

Challenges : What should we do ?

3 From Quantity to Quality

- In general, technology level remains at the level of 60 to 80% of advanced countries
  - Core components and parts, system software technology
- Although the number of SCI papers has considerably increased (14th in 2005), the citation level is still low (30th in 2005)
- Deficit in Technological Balance of Payments continues due to the lack of fundamental technology

17

Challenges : What should we do ?

4 Nurturing Cream of the Cream (HRD)

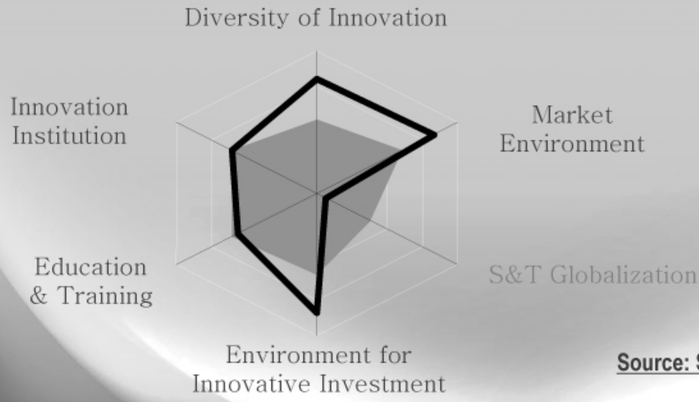
- Mismatch between demand & supply
  - Shortage of high quality manpower is expected to continue until 2015
  : Shortage of 4,500 Ph.D.s (KISTEP, '05)
- Brain drain index of IMD (2006)
  ❑ U.S : 8.96 ❑ Iceland : 8.36 ❑ Japan : 6.75 ❑ China : 3.22 ❑ Korea : 4.91

HRD	Fostering creative core manpower
Selection & concentration	R&D-oriented university
Strengthening of network	Brain Drain Brain Circulation

18

Challenges : What should we do ?

5 **Active Globalization of S&T**



Source: STEPI (2006)

Korea's overall capacity for technological innovation is relatively high while the level of S&T globalization is the lowest among OECD countries

IV. New National Innovation System

New S&T Environments

What were changed and/or the problems ?

- IT becomes a strong base of the industrial structure and society
- Rapid growth of R&D expenditure : $ 4M ('63) → $ 23,580M ('05)
- Increase of R&D sponsoring ministries : 2('82) → 18('05)
- Increase of researchers : 5,628('70) → 234,702('05)
- Weak linkage among industry, academia, and research institutes
- Mismatch between demand and supply of R&D manpower

Needs for future development

- Emphasis on innovation oriented S&T activity
- More effective government reaction and efficient resource allocation

21

Directions of National Innovation Strategy

Four(4) Major Directions

Imitation mode → Innovation mode

(1) Efficient Allocation and Utilization of R&D resources (Selection and Concentration)

(2) Strengthening of innovation capabilities (Human resources)

Closed mode → Open and networked mode

(3) Collaboration among industry, academia, and GRIs

(4) Openness

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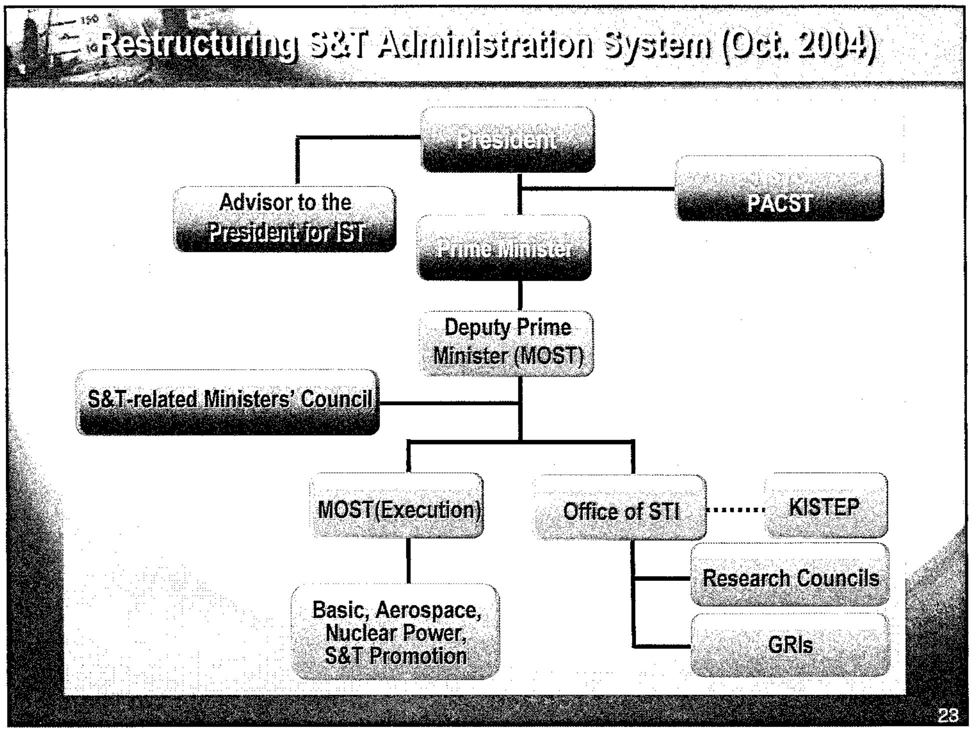
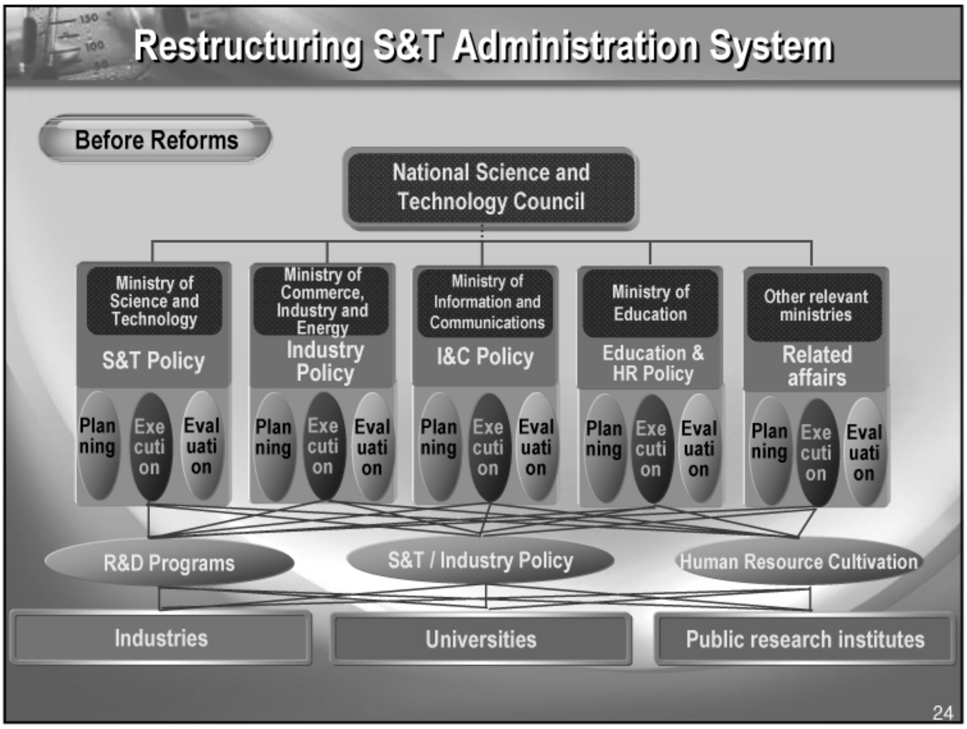
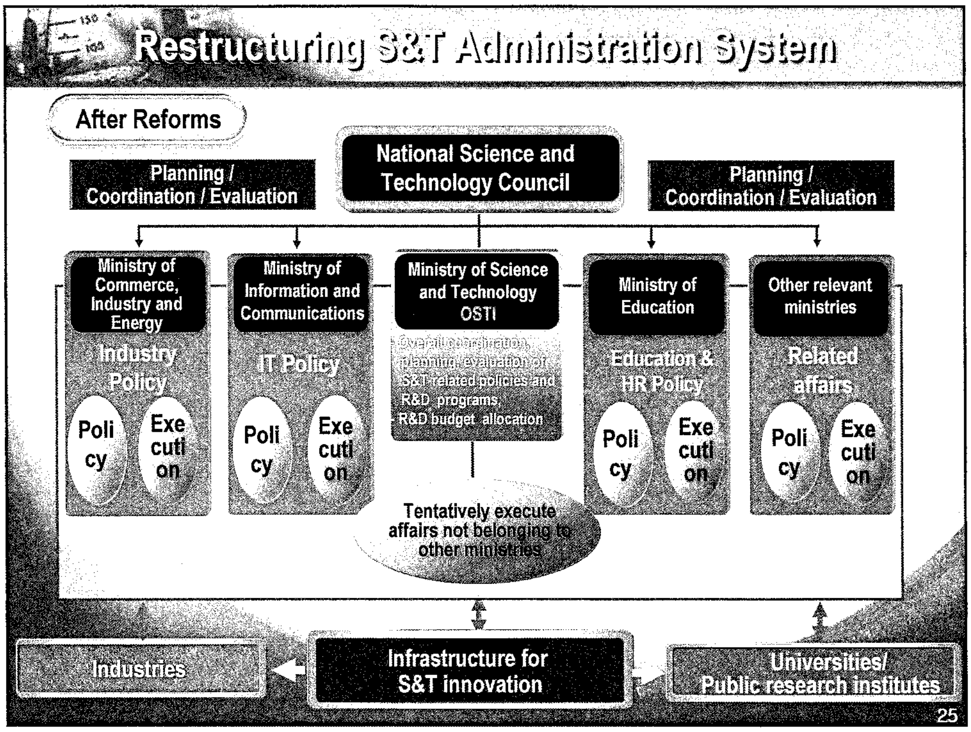
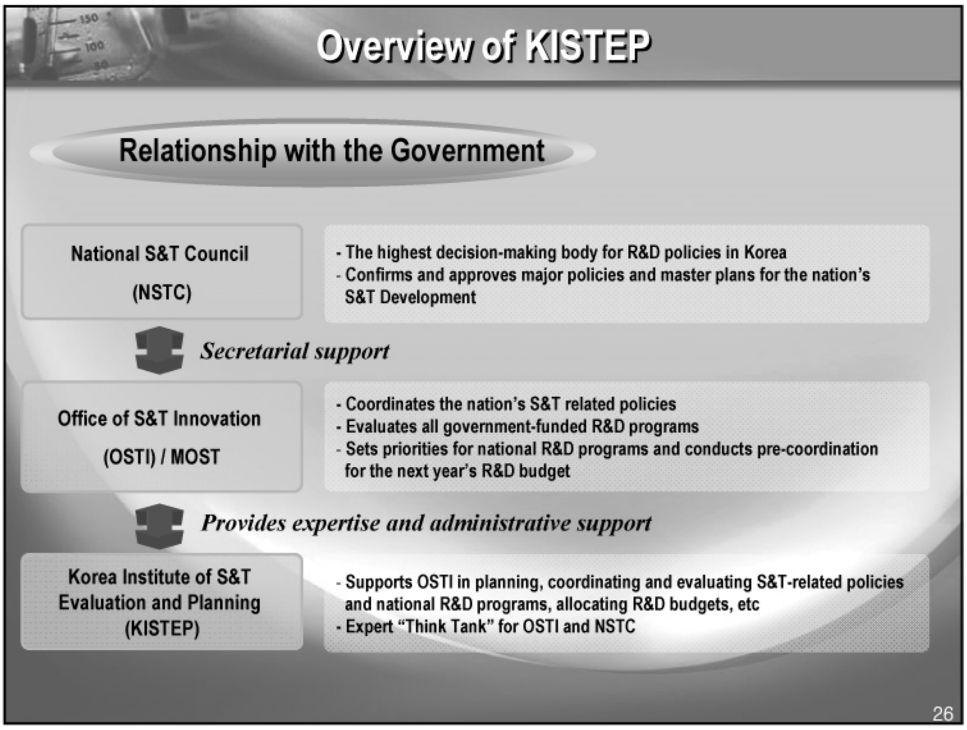
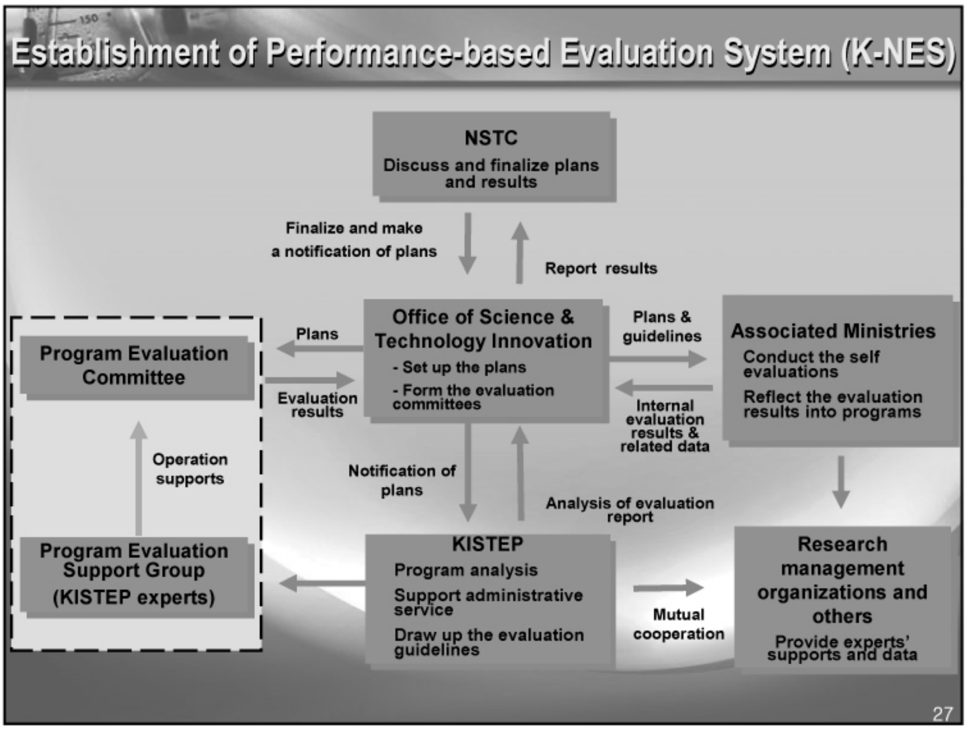
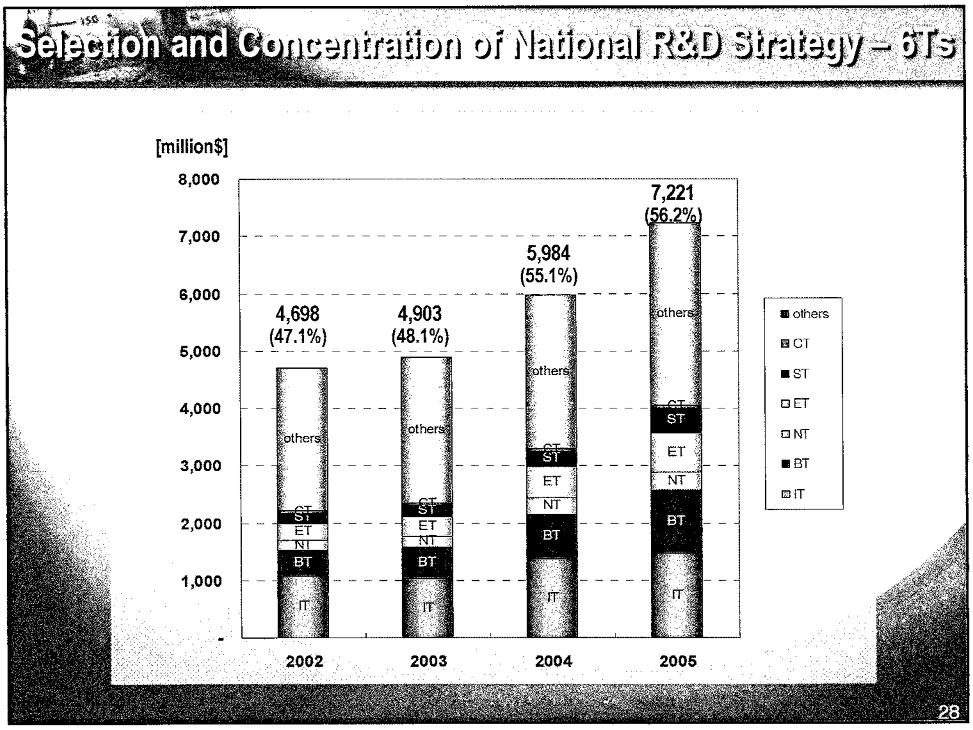

Restructuring S&T Administration System (Oct. 2004)
President
Advisor to the President for IST
PACST
Prime Minister
Deputy Prime Minister (MOST)
S&T-related Ministers' Council
MOST(Execution)
Office of STI
KISTEP
Research Councils
Basic, Aerospace, Nuclear Power, S&T Promotion
GRIs
23


Restructuring S&T Administration System
Before Reforms
National Science and Technology Council
Ministry of Science and Technology
S&T Policy
Ministry of Commerce, Industry and Energy
Industry Policy
Ministry of Information and Communications
I&C Policy
Ministry of Education
Education & HR Policy
Other relevant ministries
Related affairs
Planning Execution Evaluation
R&D Programs
S&T / Industry Policy
Human Resource Cultivation
Industries
Universities
Public research institutes
24


Restructuring S&T Administration System
After Reforms
National Science and Technology Council
Planning / Coordination / Evaluation
Planning / Coordination / Evaluation
Ministry of Commerce, Industry and Energy
Industry Policy
Poli cy
Exe cuti on
Ministry of Information and Communications
IT Policy
Poli cy
Exe cuti on
Ministry of Science and Technology OSTI
Overall coordination, planning, evaluation of S&T-related policies and R&D programs, R&D budget allocation
Ministry of Education
Education & HR Policy
Poli cy
Exe cuti on
Other relevant ministries
Related affairs
Poli cy
Exe cuti on
Tentatively execute affairs not belonging to other ministries
Industries
Infrastructure for S&T innovation
Universities/ Public research institutes
25


Overview of KISTEP
Relationship with the Government
National S&T Council (NSTC)
- The highest decision-making body for R&D policies in Korea
- Confirms and approves major policies and master plans for the nation's S&T Development
Secretarial support
Office of S&T Innovation (OSTI) / MOST
- Coordinates the nation's S&T related policies
- Evaluates all government-funded R&D programs
- Sets priorities for national R&D programs and conducts pre-coordination for the next year's R&D budget
Provides expertise and administrative support
Korea Institute of S&T Evaluation and Planning (KISTEP)
- Supports OSTI in planning, coordinating and evaluating S&T-related policies and national R&D programs, allocating R&D budgets, etc
- Expert "Think Tank" for OSTI and NSTC
26


Establishment of Performance-based Evaluation System (K-NES)
NSTC
Discuss and finalize plans and results
Finalize and make a notification of plans
Report results
Office of Science & Technology Innovation
- Set up the plans
- Form the evaluation committees
Plans
Evaluation results
Plans & guidelines
Internal evaluation results & related data
Program Evaluation Committee
Operation supports
Program Evaluation Support Group (KISTEP experts)
Associated Ministries
Conduct the self evaluations
Reflect the evaluation results into programs
Notification of plans
Analysis of evaluation report
KISTEP
Program analysis
Support administrative service
Draw up the evaluation guidelines
Mutual cooperation
Research management organizations and others
Provide experts' supports and data
27


Selection and Concentration of National R&D Strategy – 6Ts
[million$]
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
4,698 (47.1%)
4,903 (48.1%)
5,984 (55.1%)
7,221 (56.2%)
others
CT
ST
ET
NT
BT
IT
2002
2003
2004
2005
28

Effective Utilization of Human Resource

- Overcome the mismatch between supply and demand of Human Resource in S&T (HRST) by promoting demand-oriented education

- Build systematic linkage through the career development process of HRST
  Ex: Training school for talented in S&T - Special High School for S&T - KAIST

- Promote the participation of women in education, and labor market participation in S&T fields
- Proportion of women among total researchers ('05, headcount): 12.9% (very low compared to other OECD countries)

- Foster research universities and increase their international competitiveness in research and education
  Ex: Brain Korea Program by MOE (now in second stage)

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Global Collaboration

Direction and Strategy of S&T Cooperation

Direction

- ❖ Application of overseas S&T resources
- ❖ Contribution to making world S&T development and solving global issues
- ❖ S&T Partnership with major and developing countries

Strategy

Application of overseas S&T resources	Strategic S&T cooperation for each area	Multilateral S&T cooperation programs
➢Strong global R&D network ➢Inviting overseas research institutes ➢Expanding entrance to oversea research powerhouse ➢Collect/use overseas S&T information	➢Complementary cooperation w/advanced countries to enhance S&T ➢Long-term cooperation w/developing countries	➢Addressing new world order ➢Joining multilateral cooperation programs

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V. What should we learn ?

What should we learn ?

- Economy-embodied S&T
- Selection & Concentration
- The ultimate key player of R&D should be the private sector.
- Effective S&T system
- Globalization


THANK YOU !
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Q&A Session

Dr. Hill: Our thanks to all of our speakers for very stimulating, interesting, and informative presentations on the past, present and future directions and innovation policy in three very important countries. Their work is important to their own countries, important to the world system, and certainly important to those of us here in the United States, Europe and elsewhere.

We have about 25 minutes for questions and answers for these three speakers. I would ask those of you who ask questions to stand and identify yourselves. I will try to repeat the question briefly and pass it on to whoever you ask. I wonder if I might take the prerogative of the chair to ask the first question.

Richard Nixon once said that, "we are all Keynesians now," but it seems to me that in the 21st century we have all become Schumpeterians. That is, we all believe in the importance of creative destruction, in the role of the entrepreneur, and in the constant renewal and change of systems that support, encourage and reward initiative and leadership. Each speaker talked about leadership in research, about ensuring that top researchers are performing at world standard, and about a recognition that, in some sense, performance depends on the top researchers, whether they be in government labs, industry or universities. I am wondering whether the speakers might comment on the degree to which there are long-term cultural or other barriers to the effective performance of entrepreneurial functions in each of their countries. I do not mean only business entrepreneurship but also academic and public laboratory entrepreneurship and leadership in research. If there are such barriers, what can be done to create circumstances in which people can thrive in their presence?

Mr. Tomizawa: My presentation focused on scientific research. But as the innovation capabilities, as you indicated, the culture and entrepreneurship—not only business but also research and knowledge production— is very important in Japan.

Dr. Mu: It is a very difficult question. Because in China nowadays, entrepreneurship, theoretically speaking, does not have any problems; but there are some barriers for them to run business or to perform. For example, nowadays when a person wants to start business it is very difficult to get money. The seed funds seem to be very difficult to have. There are many other problems or barriers which have to some extent been solved in the supportive policies newly issued last year. But detailed implementing policies are still in the policymaking process. As I mentioned, there are also cultural and institutional problems to some extent. Entrepreneurship is very important, however, many entrepreneurs do not want to innovation if there are lots of other possibilities to make money without innovation. That is the problem.

Dr. Park: I think it is similar to China's case. Korea is a very closed society so far and I think the barriers for entrepreneurship are the culture and a closed society. We need more networking. And Koreans are very independent people. They need to get the barriers down by themselves.

Dr. Hill: I am struck once again by Dr. Mu's comment about the many ways to make money, only one of which is through innovation. I think in the United States and in European countries, we see the same thing happening. Young people recognize many ways to make money or establish a position. They do not always see innovation, research, and technology as the best way, and that can sometimes be frustrating.

Q: An entrepreneurial environment is usually characterized by very high rates of failure. How will the high rates of failure be received in your countries, if you move to an entrepreneurial environment? What will be the consequences for those who fail? Will they be allowed to try again?

Dr. Mu: The ratio of (starting business) is very small, very low. But as I mentioned, there are lots of other possibilities. So they do not want to take the risk. They run business in other fields, not in innovation. That is the problem. So we have to improve the innovation environment, so-called innovation-friendly culture or environment, which means for the government or other social classes sharing the risk for innovation. Setting up such a share mechanism, share of risk. If the private sector needs to take all the risks, I have to say that they do not want to take the way only to the innovation.

Mr. Tomizawa: In Japan I myself think it is important to have an innovation mind or challenging mind, but now the Japanese government does not have such kind of policy.

Dr. Park: I must say that I do not think Korea has that kind of policy and I am with Mr. Tomizawa.

Dr. Mu: I would like to give additional information. For example in Zhejiang province, an eastern province of China, there are a lot of small companies. There is a cluster to make it so-called "manufacturing in China." It is actually manufacturing in eastern China. But their profit does not come from the innovations. But nowadays they have money. In the second stage they want to put more money in innovations. Recently this province put more money in innovations. For example I was told that the Zhejiang province last year invested more than 1.5% - 2% of their GDP in R&D.

Q: I want to know whether there is any analysis of government research institutes or of government-supported research?

Mr. Tomizawa: I scarcely showed the graph including governmental or semi-governmental institutes, but we have analyzed such kinds of institutes. I mentioned the high performance of semi-governmental institutes. Riken is the most important contributor of this high performance.

Q: Is there any comparison between universities and government research institutes?

Mr. Tomizawa: We tried such kind of analysis but I do not think it is adequate to compare university and such a strong institute. The condition is different.

Dr. Park: We did not perform the comparison between the universities but I think the Ministry of Education in Korea will do such things.

Dr. Mu: China has one city named science and technology city. It is in the Sichuan province in Mianyang. This city is originally focused on the commercialization of the science and technology achievements made by some research institutions located in Mianyang city. If we consider the density of science and technology activities, maybe the largest city is Beijing; but Beijing is the capital city so they do not need the name of science and technology city. They have many other choices. The second largest city is Shanghai. Shanghai is also international, and less ready to have such a name. Third might be Nanjing or Xian. Besides them, one of such cities is Hefei in Anhui province because there are several big science programs in Hefei. If we see the density, Hefei is really another science city.

Q: Is there a mechanism to encourage scientists and engineers to publish more papers or to apply for patents?

Dr. Mu: I have to say it is difficult to set up a mechanism to increase the productivity of the scientists and engineers for them to publish or apply for the patents. In China, we have some problems. For example universities encourage professors to publish more papers. They provide some awards, even bonus for their publications. These professors are encouraged to do some publishable work instead of valuable work. It is dangerous for the development of science technologies.

Dr. Hill: Yes, Professor Edwards Deming said, “anything you measure gets better,” but the problem is that anything you do not measure gets worse. So, if you measure the wrong things you can create bad incentives for improvement.

Q: Does Dr. Mu expect China to be number one in science publications and when?

Dr. Mu: Look at the population, I think it is possible. Maybe in 50 years. But I think the quantity is meaningless. The quality is meaningful.

Dr. Hill: In 50 years we will come back and check.

Q: How do you assess the contribution of “management of technology” programs in Japan?

Mr. Tomizawa: The Japanese government has many programs in such fields. We analyze the effective policies. The policies are progressing but it is too early to assess the results now. It needs some more time to have an effect.

Dr. Hill: I want to close with an observation. We in the United States are honored that our guests from Korea, China and Japan all chose to deliver their talks in English. They did so to help those for whom English is our native language and probably the only language many of us know well. But, they also did this because English has become the common language of dialogue among most advanced nations. However, if Dr. Mu is right and China becomes “Number One” in research in 50 years, this conversation will not take place in English but more likely in Mandarin, so most of us better start learning Chinese. I thank all of you for coming. I also want to thank our speakers and our organizers for their hard work on this symposium. Thank you. We are adjourned.

end